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INFLUENCE OF THE ENVIRONMENT ON POTATO MOSAIC SYMPTOMS

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INTRODUCTION

The mosaic disease of potatoes is one of the most common and widespread of potato diseases. Because of its economic phases it has become a matter of considerable importance to understand the relation of environmental conditions to the disease as bearing on field inspection, seed certification, seed selection, and potato indexing. Environmental studies are of considerable scientific interest as well, since the nature of the causal agency of the virus diseases to which potato mosaic belongs never has been definitely ascertained. It is now generally recognized that low temperatures are conducive to the development of symptoms of potato mosaic and that high temperatures mask the symptoms. No information exists, however, as to how long these higher temperatures must be maintained in normal daily fluctuations in order to bring about masking. The investigations reported in this paper deal mainly with this problem, together with a study of other environmental conditions which might conceivably affect the symptoms of potato mosaic.

REVIEW OF PREVIOUS WORK

Potato mosaic was not definitely recognized as such until about 1911 (34), but the disease undoubtedly existed many decades before this. Schacht (40), as early as 1856, and Kühn (23), in 1872, noted that weather conditions influenced the Kräuselkrankheit of potatoes. This disease may have been caused by potato mosaic or a combination of potato viruses. In recent years, since the definite recognition of mosaic as a single disease or a group of diseases on the potato, a number of observers have noted that environmental conditions influence the symptoms: Stakman and Tolaas

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(43), Freiberg (12), Melhus (27), Murphy (28, 29, 30, 31, 32, 33), Schultz et al (41), Folsom (10), Schultz and Folsom (42, 11), Cotton (3, 4), Dickson (5, 7), Edgerton and Tiebout (9), Orton (35), Quanjer (38), Ducomet (8), Link (24), MacMillan (25), and Hungerford and Raeder (16). With the exception of Freiberg, however, none of these writers made any serious attempt to determine experimentally just what environmental factor was concerned with the modification of symptoms, although temperature among other factors was generally believed to be responsible.

Johnson (18, 19) was the first to make a detailed study in an attempt to determine which of the environmental factors were responsible for masking and where the dividing line occurred which separated the symptoms of mosaic from masking. Early recognizing the need for more reliable data on air temperatures, he undertook a series of experiments in an attempt to determine the critical air temperature for potato mosaic. He designed and constructed three simultaneously operated constant air-control chambers having thermostatic control, refrigeration within the cooler chambers, an automatically controlled humidifying system for each chamber, and means for renewal and circulation of air within the chambers. A description of the chambers has been published, but, since that time, they have been modified and improved. Johnson's method consisted of placing young potato plants already showing mosaic symptoms in the air-control chambers and keeping them there continuously for one to two weeks at various temperatures. It was found that the disease could be inhibited at as low a temperature as 23° to 24° C. Below that point symptoms of mosaic were readily induced, while above it masking occurred. Above the critical temperature, new leaves appeared, free from symptoms, while the symptoms in the older leaves gradually became less distinct and finally disappeared.

Goss (13), and Peltier and Goss (36), working in Nebraska under controlled conditions comparable to those under which Johnson's experiments were conducted, substantiated the latter's results in general. Further studies on the effect of air temperature recently were reported by Goss and Peltier (14); and a preliminary note on the principal conclusions drawn in the present paper has already been published (45).

Light is the only other environmental factor which has received special experimental consideration. Schultz and Folsom (42), Ducomet (8), MacMillan (25), Link (24), and Goss (13) seemed to agree that more distinct symptoms occurred on shaded than on unshaded potato mosaic plants, although Goss and Peltier (14) later concluded that light intensity had no effect on potato mosaic symptoms.

Soil temperature and soil moisture were believed by many writers to be responsible in part for the variation in potato mosaic symptoms as evidenced

by the observations of Ducomet (8), Murphy (30, 31), Orton (35), and Goss (13). In general, these writers noted that low soil temperatures and high soil moisture were apparently more favorable for mosaic symptoms on the potato. Goss and Peltier (14) later concluded that these factors had no direct effect upon potato mosaic symptoms.

Ducomet (8) and Link (24) believed that atmospheric humidity had some influence on potato mosaic symptoms.

Some attempt has been made to modify the symptoms of mosaic by varying the soil nutrients, apparently without success, as reported by Schultz and Folsom (42); although Perret (37) and Butler (2) claim to have masked mosaic by heavy manuring.

DESCRIPTION OF THE TYPE OF POTATO MOSAIC USED

Considerable confusion exists at present in regard to the classification and description of potato mosaic. It was first described as a separate form of virus disease by Orton (34) in 1914, the description being based upon observations made in Germany in 1911. Soon thereafter Quanjer (38) distinguished between mosaic and the leaf-rolling type of degeneration. At present, according to published reports, there are ten or more kinds of degeneration diseases.

Several classifications have been offered in recent years as a means of distinguishing between the various degeneration diseases of the potato. In 1921–1923, Quanjer (39) listed eight different potato virus diseases occurring in Europe, three of which are distinct types of mosaic. In 1921, Murphy (29) named but one type of potato mosaic, later adding a supplement (30) in which he distinguishes between simple mosaic and crinkle. Schultz and Folsom (42) have named seven types of degeneration diseases of the potato, three of which are forms of mosaic.

On the basis of these descriptions it is very difficult, if not impossible, for the widely separated workers to use them reliably and to interpret results therefrom. For instance, Quanjer (39) was not working with mosaic on the Triumph variety in Holland, and, inasmuch as he did not personally see the type of mosaic used at Wisconsin, it would appear that he may have been in error in stating that Johnson (19) confused crinkle with mosaic in experiments made in 1921. On the other hand, the confusion is apparently simply a question of nomenclature and a matter of acceptance of classification. Whatever may be the final name applied to the disease that Johnson worked with, it was unquestionably one form of potato mosaic and the same type as that with which this investigation is concerned. The type of mosaic worked with by Johnson in no way corresponds with Quanjer's crinkle, as judged either by the description or by the plate.

The type of mosaic used in connection with the intermittent air temperature and other environmental experiments will be referred to as typical Wisconsin Triumph mosaic. According to Schultz, who has personally seen the type of mosaic used in my experiments and in those of Johnson's, the marked type of Triumph mosaic should be classified as rugose mosaic. The description of mottling and wrinkling by Schultz and Folsom (42) satisfactorily describes these effects on Wisconsin Triumph potatoes. In general, mosaic potato plants have a chlorotic color compared with healthy ones.

In the following experimental data the term masking is used frequently. By masking is meant primarily the absence of the symptoms of mosaic on plants or parts of plants which are affected with the disease following the required incubation period. Complete masking makes it impossible to distinguish between mosaic and healthy leaves from plants produced from previously tested tubers. It is not understood that this represents recovery in the true sense of the word, because the virus is still present in the leaves, as may be demonstrated by exposing the plants constantly to air temperatures favorable for the development of symptoms.

EXPERIMENTAL RESULTS

Influence of Air Temperature

The experimental results secured by Johnson (19), and corroborated by Goss (13), apparently established the critical temperature for masking of the typical Wisconsin Triumph potato mosaic at approximately 24° C. under a continuous exposure to this temperature. The value of these data was interpreted particularly in terms of weekly, monthly, or seasonal variations in temperature. Under practical cultural conditions, however, crops are ordinarily subjected to a wide daily fluctuation in temperature. The critical temperature lies at such a point that under average conditions it is easily conceivable that during half of the day conditions are favorable for the disease and during the remaining half favorable for masking. Under mountain conditions in Colorado, or under northern conditions in the Wisconsin potato districts, high temperatures at noon and relatively low temperatures at night are generally the rule rather than the exception. Under these conditions of daily fluctuation of temperatures, masking occurs, as is evidenced by personal observations and reports from the observers to whom reference has already been made. It was natural to suppose, therefore, that the length of actual exposure to temperatures above and below the critical temperature might be of considerable importance in the phenomenon of masking. The experimental results on temperature reported in this paper are primarily concerned with the effect of varying lengths of ex-

posure of mosaic potato plants to temperatures favorable and unfavorable for symptoms of the disease.

Experimental Equipment and Methods Used. The experiments were performed in the greenhouses at the University of Wisconsin, using the same constant air-control chambers used by Johnson (18). Three chambers were operated simultaneously at different temperatures. The thermometers in the chambers were frequently compared with standard thermometers. The air temperature in each of the chambers usually did not vary more than one degree Centigrade. The humidity in the air-control chambers was regulated so that the evaporating power of the air in each chamber, as determined by Livingston atmometers, was approximately the same. Since the experiments in the greenhouses and in the chambers were conducted during the short days of the winter months, the plants naturally did not have normal light. However, judging from the appearance of the plants, they did not suffer seriously from lack of light, and it is not believed that this factor influenced the results.

Plants were exposed in the chambers simultaneously at such a time during the day as might most closely approximate field conditions. For example, in giving a two-hour exposure, plants were placed in the chambers at 11:00 A. M. each day and removed at 1:00 P. M. After exposure in the air-control chambers, the plants were returned to a cool greenhouse in which the air temperature was especially favorable for mosaic symptoms (ranging from 12° to 16° C.), and in which light and humidity conditions were uniformly good. The plants were kept in the cool greenhouse for 22 hours and then again placed in the chambers.

In all of the experiments, with but few exceptions which are noted elsewhere, Triumph stock grown under Wisconsin conditions was used. In several experiments, the People's was used, a late variety belonging to the Pearl group as given in Stuart's classification (44). Its culture in the United States is confined almost exclusively to western Colorado.

All tubers were first indexed in 4-inch porous clay pots as a test for mosaic. It was comparatively easy to differentiate between healthy and mosaic plants very soon after the young sprouts had broken through the soil. The young plants were then transferred to 6-inch pots and observed for one to several days prior to starting an experiment. The plants usually averaged about one inch in height at the time an experiment began. All experiments covered a period of at least two weeks. Well-drained fertile soil was used. Sufficient water was added to the soil each day to keep the plants well supplied, but no attempt was made to measure and regulate the amount of moisture. The soil temperature in the pots was approximately equal to the air temperature of the chambers.

In general, three mosaic plants and one healthy plant were placed in each air-control chamber; while the controls, consisting of the same number of plants, were kept in the cool greenhouse continuously.

Greenhouse Experiments. Mosaic and healthy plants one inch high were exposed in the air-control chambers 9 hours daily, from 7:30 A. M. until 4:30 P. M., at temperatures of 15°, 24°, and 28° C. respectively. Between 4:30 P. M. and 7:30 the next morning, the plants were kept in a cool greenhouse. The plants were in the chambers, therefore, 9 hours out of every 24, and in a cool greenhouse the remaining 15 hours. Control plants, healthy and mosaic, remained in the cool greenhouse continuously. Masking of the symptoms at the two higher temperatures was obtained in 7 days, *i.e.*, new leaves emerging from the bud showed solid dark-green, flat foliage, indistinguishable from healthy foliage. The lower or older leaves still showed some mottling, but the wrinkling effect had disappeared. With intermittent exposures, just as in the case of constant exposures, masking occurs first and proceeds more rapidly in young tissues than in older leaves. At 15° C., mottling and wrinkling remained unchanged, but small necrotic areas developed in the diseased leaf tissue. Likewise diseased control plants remaining continuously in the cool greenhouse

TABLE 1.—*Average leaf area of mosaic plants exposed for two hours a day at different temperatures*

Temperature in degrees C.	Average leaf area in square inches
15	11.41
24	12.53
28	23.90
15 (Controls)	8.13

developed necrotic areas. Healthy plants used as controls at the higher temperatures showed slight chlorosis and dropping of some of the lower leaves, while at the lower temperature and in the cool greenhouse the controls retained their dark green foliage. (See table 2 and Plate XXVIII.)

After the intermittent exposures were discontinued, the plants were allowed to remain in the cool greenhouse continuously. Mottling again developed after 13 days on new leaves of mosaic plants which had been exposed at 24° C. Symptoms became visible after 18 days on mosaic plants which had been exposed at 28° C. Masking is therefore only temporary, and mosaic symptoms are again induced by exposure to low temperatures. It is not known whether the virus is present in the leaf in the same proportions during the period of masking as it is when the leaf is mottled. This probably could be determined only by a series of dilution inoculations to healthy potato plants.

Four additional experiments were conducted at the same temperatures with intermittent exposures of 2, 3, 4, and 5 hours respectively. Results obtained were confirmatory of the experiment described above; these are given in table 2 (Plate XXIX). Referring to table 1, it may be noted that almost three times as much leaf tissue developed in the mosaic plants at 28° C. as in the controls (Plate XXX).

In a second series of experiments, diseased and healthy plants were exposed in the chambers at higher temperatures, namely, 20°, 30°, and 40° C., while the length of exposure varied from 2 to 6 hours (table 3, Plate XXXI). At 40° C., exposure seemed to induce not only excessive

TABLE 2.—*Time required for masking of mosaic plants exposed for different lengths of time at different temperatures*

Temperature in degrees C.	No. of hours of exposure a day	No. hours in greenhouse at 15° C. a day	No. days required for masking
15	9	15	No masking
	5	19	do
	4	20	do
	3	21	do
	2	22	do
24	9	15	7
	5	19	25
	4	20	33
	3	21	38
	2	22	42
28	9	15	7
	5	19	15
	4	20	17
	3	21	20
	2	22	28
15 (Controls)	0	24	No masking

chlorophyl production but stunting of the plants as well.

Temperatures of 15°, 24°, and 28° C. were used in a series of experiments with the People's variety in which exposures were made in the chambers at night (Plate XXVIII). Table 4 shows the time required for masking when plants were exposed for different lengths of time at different temperatures.

Again referring to table 2, it was found that mosaic plants can be masked in 15 days with a 5-hour exposure at 28° C. and in 25 days at 24° C.

Further experiments were conducted to determine whether masking could proceed to completion if a continuous 5-hour intermittent exposure were broken up into five integral parts; exposing the plants for one hour in the chambers, followed by one hour at a low temperature outside the chambers, then placing the plants in the chambers again for another hour, and continuing the process until a total exposure of 5 hours had been given. Triumph stock from Florida was used. Temperatures in the chambers were held at 23°, 29°, and 35° C. Plants were placed in the chambers at 7:30 A. M., 9:30 A. M., 11:30 A. M., 1:30 P. M., and 3:30 P. M., being removed therefrom during the alternate hours to a cool greenhouse. After completion of the total 5-hour discontinuous exposure, the plants were kept the remaining number of hours in the cool greenhouse. Diseased plants at 29° and 35° C. were masked in 8 days. This indicated that masking could be secured with a discontinuous exposure.

TABLE 3.—*Time required for masking of mosaic plants exposed for different lengths of time at different high temperatures*

Temperature in degrees C.	No. hours of exposure a day	No. hours in greenhouse at 15° C. a day	No. days required for masking
20	6	18	No masking
	4	20	do
	2	22	do
30	6	18	6
	4	20	9
	2	22	13
40	6	18	4
	4	20	5
	2	22	7
15 (Controls)	0	24	No masking

It then became of some interest to know whether a continuous 5-hour intermittent exposure could produce masking more quickly than a 5-hour discontinuous exposure. Two series of pots, each series having three mosaic plants and one healthy plant for each temperature, were used. Temperatures of 23°, 29°, and 35° C. were again employed. With one series the plants were exposed in the chambers for 5 consecutive hours, from 9:30 A. M. to 2:30 P. M. each day. The plants in the second series were run on a discontinuous schedule, commencing at 7:30 A. M. with exposures in the chambers. Masking was secured in 7 days in plants given a con-

tinuous 5-hour intermittent exposure, while a 5-hour discontinuous exposure required 13 days to bring about masking at 35° C.

Effect of Date of Planting on the Symptoms at High Altitudes. According to MacMillan (25), the symptom of mottling does not appear in potatoes grown at an altitude of 8,000 to 8,500 feet above sea level.

Tuber indexed stock was shipped from Wisconsin to Colorado in the spring of 1924 and planted at an elevation of 8,000 feet near Eagle, Colorado. This work was conducted as an experiment to test the effect of high altitude on Wisconsin mosaic stock and to determine whether or not, under field conditions, masking could take place as a result of short intermittent exposures at air temperatures above 23° to 24° C. Three plantings were made, 10 days apart, commencing on May 20 and ending June 9. The average day and night air temperatures are given in table 5.

The lot planted earliest came through the soil showing typical mottling, although it was not of the same pronounced type as is encountered in in-

TABLE 4.—*Time required for masking of mosaic plants exposed at night for different lengths of time at different temperatures*

Temperature in degrees C.	No. hours of exposure a night	No. hours in greenhouse at 15° C. a day	No. days required for masking
15	15	9	No masking
	9	15	do
	3	21	do
24	15	9	8
	9	15	17
	3	21	21
28	15	9	8
	9	15	12
	3	21	15
15 (Controls)	0	24	No masking

dexing work under greenhouse conditions. Mottling and wrinkling of the leaves were plainly visible until July 2, at which time all symptoms disappeared. With the second planting, symptoms were visible until the same date, when they too disappeared. The third lot never showed any symptoms. When the sprouts came up, the air temperature was above that of the critical temperature for short periods each day from June 24 on, long enough to inhibit the development of symptoms from the time of emergence from the soil, regardless of the fact that at night the air temperature dropped as low as 0° C. This small amount of field evidence

indicates that mottling may appear quite markedly in the high altitudes in Triumph stock if air temperatures are below 23° to 24° C., while higher temperatures mask the symptoms. The conclusion seems justified, therefore, that altitude has little, if any, effect on Triumph mosaic as far as mottling is concerned.

Conclusions from Air Temperature Experiments. The experimental results presented above are believed to be sufficient to justify the conclusion that relatively short exposures to high temperatures are sufficient to mask potato mosaic. This is of practical significance, since considerable fluctuations in air temperature occur throughout the entire 24 hours of the day in nature. High temperatures, as they occur under field conditions, are of an intermittent character and may persist for one to several hours. Consequently masking is not induced by constant exposures in the field but rather by intermittent exposures.

With intermittent exposures the rate of masking was found to be dependent largely upon the duration of exposure, upon the air temperature above 23° to 24° C., and upon the age of the leaves. In general, the higher the air temperature the more rapidly masking took place, within certain limits; while the rate of masking was retarded as the critical temperature was approached. Masking was first obtained and proceeded more rapidly in new young tissues than in older leaves with short intermittent exposures. Johnson's results were similar with constant exposures. At 30° to 40° C., the higher temperatures seemed to induce masking of new and old tissues with equal rapidity; at least no marked differentiation could be made between the rate of masking of old versus new tissues.

It seemed at first that masking might be associated with increased chlorophyl production. This appeared to be true when mosaic plants were exposed to intermittent high air temperatures. However, with constant exposure at similar high air temperatures, the leaves, while masked, were lighter green in color, a condition which suggested that masking may occur without increase in chlorophyl content in the leaves. In the earlier experiments, newly masked leaves produced at 24° C. contained decidedly less chlorophyl than new leaves at 28° C. The chlorophyl content developed at air temperatures of 30° and 40° C. was distinctly different from that which obtained at 24° and 28° C. Intermittent exposures at night, in comparison with day exposures, resulted in masked tissue which was paler green in color than that of plants exposed in daylight.

The first effect on the new leaves as they developed, produced by intermittent exposures during the process of masking, was wrinkling. The process was gradual but of relatively short duration. Before this was entirely accomplished, mottling began to disappear from the lamina. In general, masking proceeded from the base of the leaf next to the petiole

upward toward the apex. Masking was never considered complete in new leaves until they appeared without signs of mottling and wrinkling.

After masking, plants were then subjected to constant air temperatures below the critical air temperature, with the result that symptoms of mosaic reappeared. A longer period elapsed before the symptoms returned after a 6-hour exposure than after a 2-hour exposure at 40° C.; and the same thing was true for different length exposures at 30° C. Likewise, symptoms returned more quickly on plants exposed for 6 hours at 30° C. than on plants exposed for a similar period at 40° C. A definite rate for the return of symptoms on mosaic plants masked at different temperatures could not be established.

TABLE 5.—*Effect of air temperatures on masking of mosaic symptoms at Eagle, Colorado, season of 1924*

Period	Average air temperature in degrees C.		Results
	Day	Night	
May 19 to May 25	22	0	No masking
May 26 to June 1	12	−3	do
June 2 to June 8	20	0	do
June 9 to June 15	23	−3	do
June 16 to June 22	23	−3	do
June 23 to June 29	30	0	Masking
June 30 to July 6	30	5	do
July 7 to July 13	25	5	do

Influence of Soil Temperature and Soil Moisture

Experiments on soil temperatures and soil moistures were conducted in order to determine the extent to which these factors operate, if at all, in bringing about masking.

The soil temperature studies were conducted simultaneously with those on soil moisture. The Wisconsin soil temperature tanks, previously described by Jones (21), were used. Plants were grown in galvanized iron cans 5x8x12½ inches in size. These were immersed in tanks electrically heated and controlled by electric thermostats.

The moisture-holding capacity of the soil was determined by the 25 cm. tube method. The soil-moisture content was brought to the desired point by adding sufficient water to each can through a glass tube leading to an inverted porous clay pot and was kept approximately constant by weighing the cans daily and adding enough water to restore the desired weight. Increase in weight of the plants was not taken into account in the weighings.

TABLE 6.—*Duration of masking at different soil temperatures with different soil moistures (Experiment 1)*

Approximate soil temperature in degrees C.	Approximate percentage soil moisture	Results—Dec. 9 to Dec. 22, 1924	Results—Dec. 23 to Jan. 5, 1925
20	25	No masking	No masking
	40	do	do
	60	do	do
	80	do	do
25	25	No masking	No masking
	40	do	do
	60	do	do
	80	do	do
30	25	No masking	No masking
	40	do	do
	60	do	do
	80	do	do
35	25	Masking	Mosaic symptoms appeared Dec. 26
	40	do	
	60	do	
	80	do	

The soil temperature tanks were kept in a cool greenhouse in which the air temperature was held at approximately 15° C. Four tanks were used, the water in each of which was held at 20°, 25°, 30°, and 35° C. respectively. Each tank was supplied with a series of 10 cans. Five different soil moistures in duplicate were used in each tank, namely, 25, 40, 60, 80, and 100 per cent of the moisture-holding capacity of the soil.

TABLE 7.—*Duration of masking at different soil temperatures with different soil moistures (Experiment 2)*

Approximate soil temperature in degrees C.	Approximate percentage soil moisture	Results—Jan. 25 to Feb. 14, 1925	Results—Feb. 15 to Feb. 21, 1925
26	40	No masking	No masking
	60	do	do
29	40	No masking	No masking
	60	do	do
32	40	Masking	Mosaic symptoms appeared
	60	do	
35	40	Masking	Mosaic symptoms appeared
	60	do	

Triumph mosaic stock from Florida, previously indexed, was used. Two seed pieces, each composed of a single eye, were planted in each can. From each seed tuber used, four eyes were cut. All four seed pieces were planted in separate cans at the same percentage of soil moisture but held at different soil temperatures. This permitted observations on the same tuber as to the effect of variation in soil temperature.

At 20°, 25°, and 30° C., all plants showed mosaic symptoms. No symptoms appeared on plants at 35° C. until a height of 8 inches was attained, indicating that the point had been reached where low air temperature replaced high soil temperature as the dominating factor, thus inducing mosaic symptoms which earlier were inhibited. Neither high nor low soil moistures intensified or reduced the symptoms.

This experiment indicated that high soil temperature may be a factor in masking plants during the earlier stages of growth, even though the air temperature is favorable for mosaic symptoms. It also indicated that a critical temperature exists at about 30° to 35° C., above which there is masking of plants from the time of emergence until plants are about 8 inches high, and below which mosaic symptoms readily appear (table 6).

The results of other experiments were confirmatory and are given in table 7. It was found that temporary masking of leaves may be induced by soil temperatures as low as 32° C. (Plate XXXII).

No attempt was made to determine whether the amount of virus in the leaves during the period of masking was less than when characteristic symptoms were present.

Soil moisture exerted little or no influence on masking. There was practically no variation in the intensity of symptoms of plants growing in different moistures at the same temperature.

Influence of Humidity

Recorded observations concerning the effect of humidity on the symptoms of potato mosaic are very limited, judging from the literature. Mosaic symptoms have often appeared to be unusually marked in regions of high humidity, and in some cases this was attributed largely to high moisture content of the air. Other workers have considered low humidity which characterizes semi-arid and arid regions to be one of the primary contributing causes of pronounced masking. Up to the present time, no experimental evidence based on work conducted under controlled conditions has been presented.

A series of experiments was carried out in the control chambers in an attempt to determine to what extent humidity affects the symptoms. Three control chambers were operated simultaneously, the air temperature throughout all of the experiments recorded being held a few degrees below

that of the critical temperature, averaging 19° to 20° C. This temperature was favorable for mosaic symptoms. The humidity, on the other hand, was varied. Variations in humidity included relative humidities averaging 43, 81, and 95 per cent. The humidities were maintained at a fairly constant level by the control apparatus without great difficulty, never fluctuating more than 5 per cent except for a few minutes when the chambers were opened in order to water the plants or to attend to apparatus. The rate of evaporation was measured by three Livingston atmometers placed in each chamber. The method of experimenting was essentially the same as in the air temperature experiments. The results of four experiments are shown in table 8.

Neither high nor low humidities had any effect on the symptoms at the particular air temperatures used. Both healthy and mosaic plants exposed

TABLE 8.—*Influence of variation in humidity upon mosaic symptoms*

Experiment No.	Date performed	Comparative humidity in chambers	Approximate relative humidity	Average daily evaporation in c.c. from atmometers	Results
1	Nov. 12 to Dec. 2, 1924	Low	43	35.8	No masking
		Medium	81	15.9	do
		High	95	7.3	do
2	Nov. 19 to Dec. 2, 1924	Low	43	36.5	No masking
		Medium	81	15.5	do
		High	95	7.5	do
3	Mar. 2 to Mar. 15, 1925	Low	47	34.0	No masking
		Medium	81	15.2	do
		High	93	7.5	do
4	Mar. 9 to Mar. 22, 1925	Low	47	33.0	No masking
		Medium	81	13.9	do
		High	93	9.5	do

in the chambers had longer internodes than the controls grown in the cool greenhouse. Humidity in the cool greenhouse approximated that of the low humidity chamber and, inasmuch as the controls showed no internodal elongation, the conclusion seems warranted that light was largely responsible for internodal elongation in the case of plants in the chambers.

Influence of Light

Light is an important environmental factor, but one of such complexity that its relationship to normal plants is not perfectly understood, and still less is known about its relation to plant diseases. Under field conditions light is intimately associated with air temperature, and it is difficult

to attempt to separate one from the other. Certain investigators have demonstrated that the absorption of light by a green plant may raise the temperature of the plant from 4 to 10 degrees; hence any conclusions drawn regarding its effects are frequently open to serious question.

Many investigators, as previously noted, report that symptoms of potato mosaic are affected by shading the plants. The experiments on light were conducted to determine whether shading, colored lights, or constant exposure to light tends to increase or decrease the symptoms of the disease.

Effect of Shading with Cheesecloth. Four cages covered with white cheesecloth were used, varying from one to four thicknesses of cloth. Six mosaic potato plants of the People's variety were placed under each cage, while eight mosaic plants for use as controls were kept in the greenhouse without being covered. The air temperature in the greenhouse averaged about 20° C. and was therefore favorable for mosaic symptoms. Observations made over a period of four weeks indicated that mottling and wrinkling of the leaves were neither intensified nor reduced.

Effect of Colored Glass. Five glass chambers served for the study of the effect of colored light on the symptoms. A good grade of colored glass was used, the colors consisting of red, blue, yellow, and green, in addition to plain glass. Cold air was supplied to each chamber through rubber tubing by means of an electric blower which was in operation day and night. In no case did the air temperature exceed 23° C. The experiment was continued for two weeks. Mottling and wrinkling were reduced under green glass, while the other colors had no effect on the symptoms but did cause etiolation.

Effect of Constant Exposure to Light. Mosaic plants, one inch high, of the People's variety, were placed beneath five 200-watt lamps equipped with reflectors, distributed overhead in such a way as to cast essentially the same amount of light on each plant. The plants were exposed to continuous illumination, during the day from natural sources and at night by means of artificial light. Controls were kept in a remote part of the greenhouse, away from the electric lamps. The air temperature was favorable for mosaic symptoms. At the end of three weeks the internodes of plants under the electric lamps were much elongated in comparison with the internodes on the controls, while the leaves were smaller. In spite of the differences in growth between the two sets of plants, there was no macroscopic difference in symptoms between the plants given continuous light and the controls.

Other experimental results were confirmatory. The conclusion is drawn that shading with cheesecloth, colored lights, or constant illumination does not intensify mosaic symptoms, or reduce them, so far as macroscopic observations are concerned when the experiments are conducted during winter months under greenhouse conditions.

Influence of Nutrition

So far as can be ascertained, no studies have been reported on the influence of nutrition on the symptoms of potato mosaic where pure sand cultures were employed.

Johnston (20) determined the proportion of salts necessary to produce the best growth of potato plants by means of sand cultures. Potato sprouts were grown in a series of solutions consisting of 21 different salt proportions of monobasic potassium phosphate (KH_2PO_4), calcium nitrate ($Ca(NO_3)_2$), and magnesium sulfate ($MgSo_4$). He found that the average highest yielding culture contained the three salts in the following volume-molecular concentration: KH_2PO_4, 0.0065M.; $Ca(NO_3)_2$, 0.0086M.; $MgSO_4$, 0.0021M.

Nutrient solutions were prepared on the basis of Johnston's highest yielding culture. When transposed in terms of grams, the formula for his complete nutrient solution is: KH_2PO_4, 0.8850 grams; $Ca(NO_3)_2$, 1.4111 grams; $MgSO_4$, 0.2528 grams. Four solutions were prepared, consisting of a complete nutrient solution, a solution lacking in nitrogen, another lacking in phosphorus, and still another lacking in potassium.

Two sprouts, one healthy and one mosaic, from Wisconsin Triumph indexed stock, were placed in each sand culture. The sand was first flooded with nutrient solution diluted to 10 per cent strength, followed by withdrawal so as to reduce the total amount of solution to 50 per cent of the dry weight of the sand. Moisture of the sand was kept at approximately 11 per cent, which represented 50 per cent of the moisture-holding capacity as determined by the use of Hilgard trays. During the second week a new solution of 50 per cent strength was added, followed during the third week by a solution of full strength. Liquids were withdrawn from the cultures by means of suction. No attempt was made to measure evaporation or transpiration. Air temperatures in the greenhouse fluctuated from 15° to 20° C.

Four series of three crocks each were used. To the first series complete nutrient solution was added; to the second a nutrient solution lacking in nitrogen; to the third a solution lacking in phosphorus; the fourth was supplied with a solution lacking in potassium.

At the end of the fifth week the symptoms were as marked as at the beginning. There was very little difference among the several cultures as far as growth and intensity of symptoms were concerned. Other experiments were confirmatory.

These experiments, although limited in extent, were of such a convincing nature as to discourage any expectation of altering mosaic symptoms by varying the nutrition of the plants; consequently this line of effort was discontinued. The results are believed sufficient, however, to justify the

conclusion that little or no modifying influence on mosaic results from varying the three principal elements for plant growth.

Pathological Histology in Relation to Masking

Considerable attention has been given by investigators to the histology of healthy and mosaic leaves of various Solanaceae, especially tobacco, tomato, and potato.

Koning (22) and Heintzel (15) found few deviations, microscopically, in mosaic tobacco leaves from normal healthy tissue.

Woods (47), in 1902, noted that the palisade cells of the light green areas were cuboidal in shape and found there was an abrupt change from these cells to those of the dark green areas, the latter being considered healthy.

Iwanowski (17) also noted shortened and cuboidal cells in the yellow areas.

Westerdijk (46) found no striking differences between mosaic and healthy tomato leaves, while Melchers (26) observed that yellow areas were slightly thinner than the green areas in mosaic tomato leaves.

Dickson (6), in 1921, concluded that true mosaic histological symptoms included hyperplasia of palisade parenchyma in light areas. Later he (7) found a number of variations from healthy tissue in mosaic potato leaves.

The literature apparently contains no information relative to histological studies on leaves where the symptoms have been masked as a result of high temperatures. Masked leaves present an entirely different macroscopic appearance from leaves showing symptoms, particularly with regard to mottling and wrinkling. Some histological differentiation takes place, apparently, and the investigation was commenced on this assumption.

Healthy, mosaic, and masked leaves were selected during the course of both air and soil temperature experiments. Tissue was taken from masked plants at 30° C., and from mosaic and healthy leaves at air temperatures below 23° to 24° C.; in the soil temperature experiments from healthy, masked, and mosaic plants at 32° and 35° C.

All material was killed in formal-acetic-alcohol fixative and imbedded in paraffin. Sections were cut 10 microns thick and stained with Haidenhain's iron-alum-haematoxylin and the triple combination of Flemming's Safranin, Gentian-Violet, and Orange G (in clove oil).

Influence of Air Temperature. Examination of sections from healthy tissue at both 30° C. and 15° C. disclosed no abnormalities. In mosaic tissue from leaves produced at 15° C., the well-known light and dark areas were observed. Masked leaves at 30° C. have palisade cells reduced in width and length, thus eliminating all intercellular spaces, except where certain palisade cells took a position at a slightly inclined angle to the right or

left of the vertical plane of the section. The cells of the spongy parenchyma were arranged regularly in rows, and all intercellular spaces were eliminated. A leaf in a masked condition presents two marked aspects: reduction in size in both axes and compact arrangement of palisade cells, and increase in number of spongy parenchyma cells with elimination of intercellular spaces.

No attempt was made to investigate the progressive changes in histology which undoubtedly occur from the time a diseased plant is placed in a high air-temperature chamber until the time when new leaves appear devoid of all mottling and wrinkling. Under field conditions where masking has taken place and inspection for mosaic is rendered impossible, it would seem probable that, with a knowledge of the structure of healthy, mosaic, and masked leaves in mind, leaves could be examined quickly by making free-hand sections and the presence or absence of mosaic established.

Influence of Soil Temperature. Microscopically it was impossible to distinguish between healthy and masked leaf tissues of plants grown in soil temperatures of 32° and 35° C. Development of upper and lower epidermis, palisade cells, and spongy tissue with large intercellular spaces was entirely comparable to the healthy condition.

Air Temperatures in certain Potato-growing Sections. Since intermittent high air temperatures have been shown experimentally to be of considerable importance in the process of masking of mosaic symptoms under greenhouse conditions, an attempt was made to show how these results might be of practical significance in connection with conditions obtaining under the natural environment.

The data used were compiled from the records of the United States Weather Bureau and cover the potato-growing periods of the years 1915, 1916, 1923, and 1924. Six representative potato states, including two in the South and four in the North, were selected as a basis for comparison. The maximum daily temperatures were used since it was believed this would represent more correctly the conditions which concern potato mosaic from the standpoint of masking. These figures were averaged to give the air temperatures for weekly periods upon which the conclusions have been drawn. Masking, as shown by Johnson (19), occurs only above 75° F.; below that point the symptoms show readliy. The data cover the air temperatures from the approximate time of emergence of plants from the soil until harvest.

The air temperatures at Greeley, Colorado; Fort Myers, Florida; Alexandria, Louisiana; and Spooner, Wisconsin, were brought together for comparison, based on average planting dates of May 29, December 27, January 29, and June 5 respectively. A similar comparison was made between St. Augustine, Florida; Baton Rouge, Louisiana; Orono, Maine;

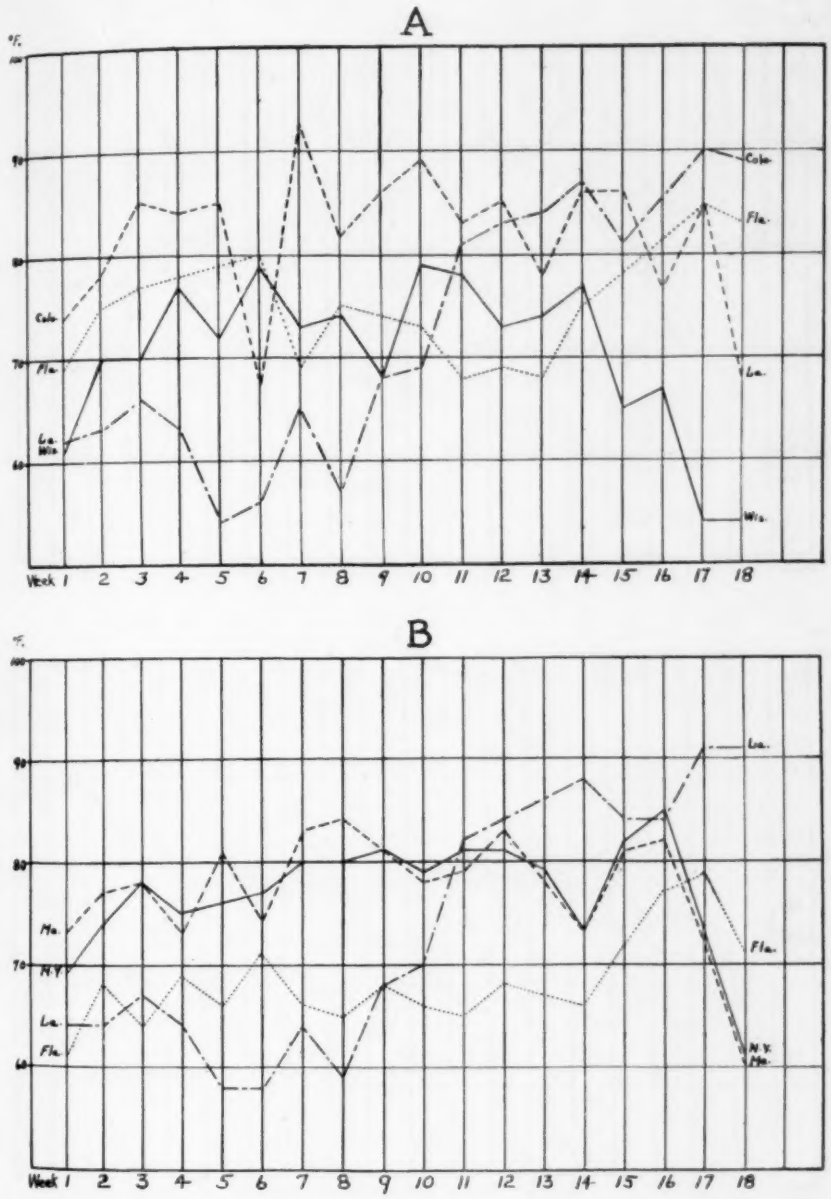

FIG. 1. Graphic comparison of average weekly maximum air temperatures prevailing in different potato-producing regions from date of planting until harvest time. 1915: A. Greeley, Colorado; Fort Myers, Florida; Alexandria, Louisiana; Spooner, Wisconsin. B. St. Augustine, Florida; Baton Rouge, Louisiana; Orono, Maine; Medford, New York.

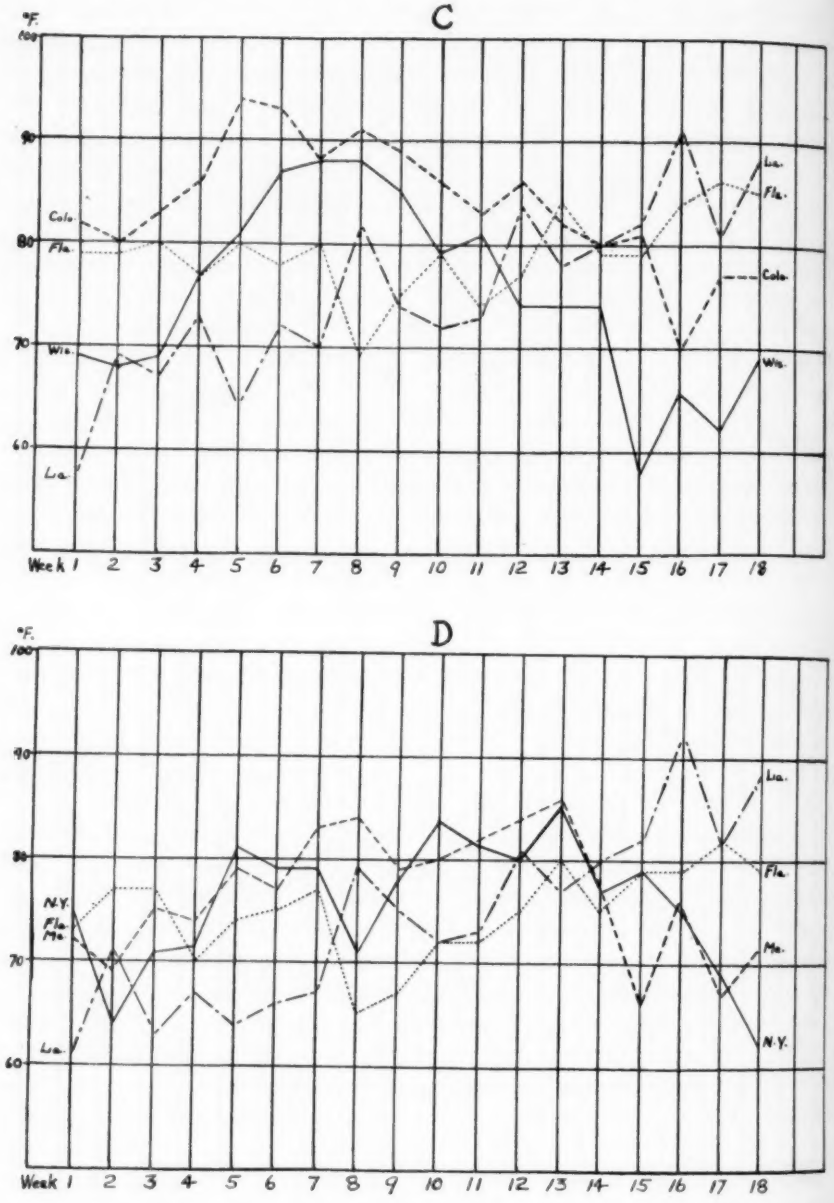

FIG. 2. Graphic comparison of average weekly maximum air temperatures prevailing in different potato-producing regions from date of planting until harvest time. 1916: C. Greeley, Colorado; Fort Myers, Florida; Alexandria, Louisiana; Spooner, Wisconsin. D. St. Augustine, Florida; Baton Rouge, Louisiana; Orono, Maine; Medford, New York.

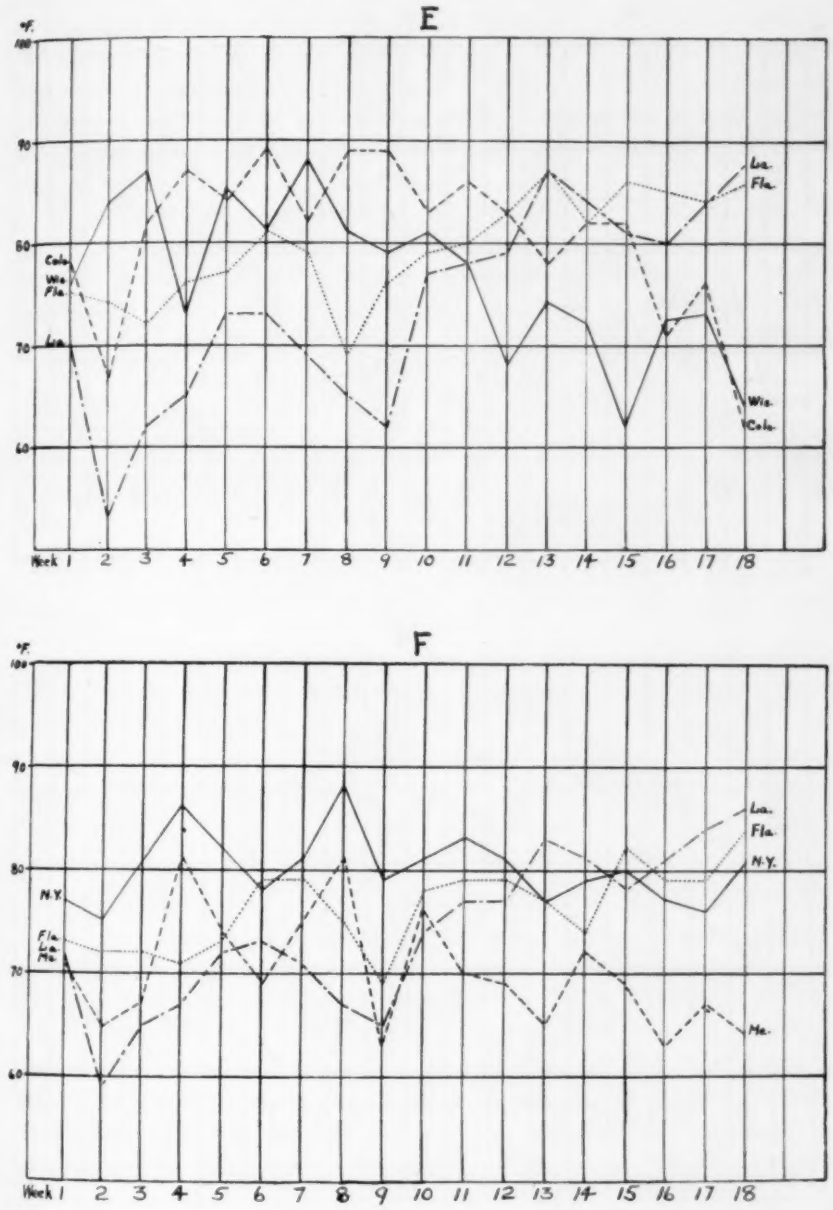

FIG. 3. Graphic comparison of average weekly maximum air temperatures prevailing in different potato-producing regions from date of planting until harvest time. 1923: E. Greeley, Colorado; Fort Myers, Florida; Alexandria, Louisiana; Spooner, Wisconsin. F. St. Augustine, Florida; Baton Rouge, Louisiana; Orono, Maine; Medford, New York.

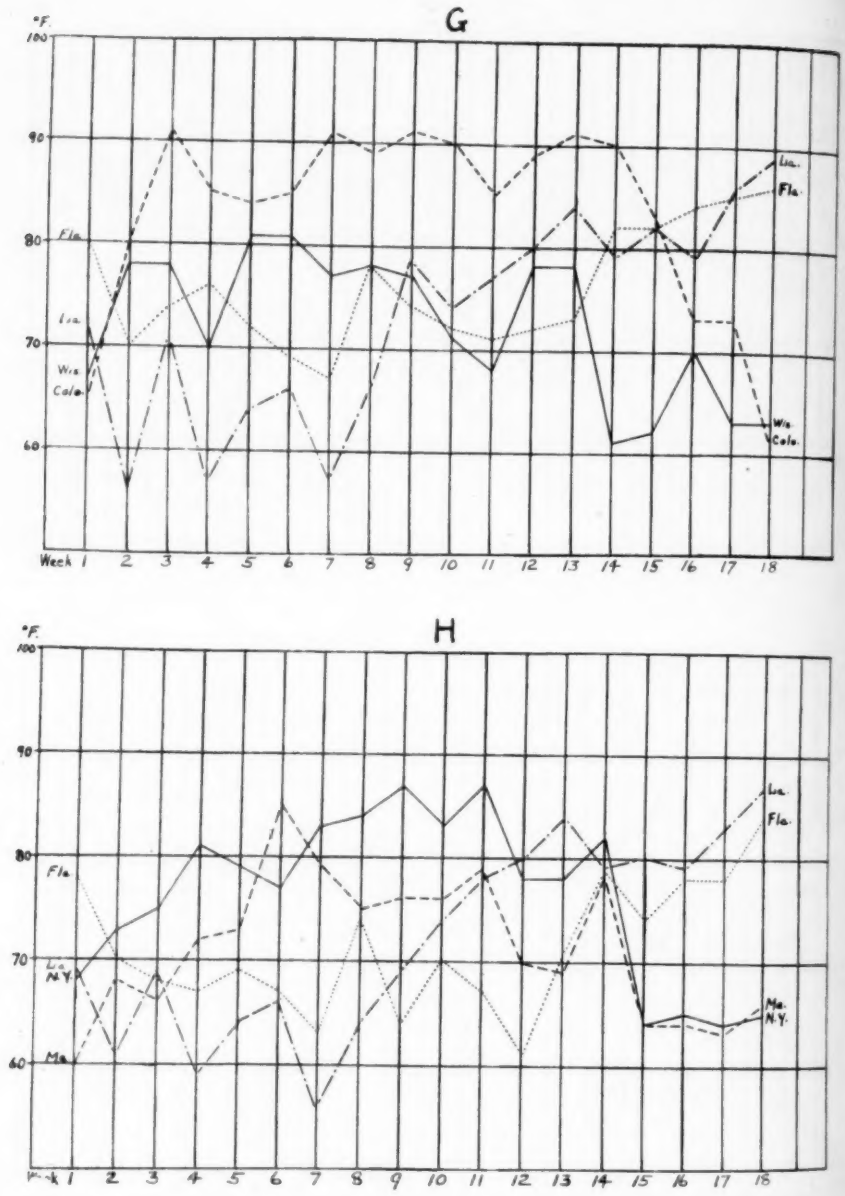

FIG. 4. Graphic comparison of average weekly maximum air temperatures prevailing in different potato-producing regions from date of planting until harvest time. 1924: G. Greeley, Colorado; Fort Myers, Florida; Alexandria, Louisiana; Spooner, Wisconsin. H. St. Augustine, Florida; Baton Rouge, Louisiana; Orono, Maine; Medford, New York.

and Medford, New York, whose average planting dates were December 27, January 29, May 29, and May 29 respectively. The air temperature records in each series are believed to be representative of conditions in the surrounding commercial potato-producing sections. The approximate dates of planting naturally do not coincide in the comparative graphs, but that is immaterial since the growing season itself was considered and not the time of year.

An attempt has been made to correlate the conclusions drawn from the climatological data with experimental results on air temperature. For example, at 30° C. (86° F.), with a 6-hour intermittent exposure, masking occurred in 6 days; while at 28° C. (81° F.) masking occurred in 7 days with a 9-hour intermittent exposure. Masking undoubtedly proceeds at a

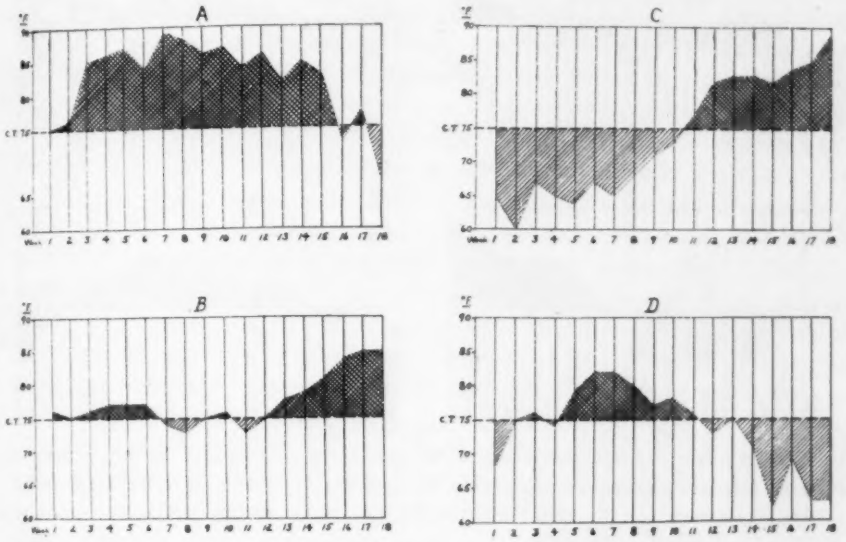

FIG. 5. Graphic representation, based on a 4-year average of maximum daily air temperatures, showing periods favorable for masking of symptoms in different potato-producing regions. A. Greeley, Colorado. B. Fort Myers, Florida. C. Alexandria, Louisiana. D. Spooner, Wisconsin.

more rapid rate in the field because the symptoms are less marked outdoors than on diseased plants produced under a more uniform air temperature in a greenhouse. Employing the six-hour exposure as a basis of comparison, figures 1, 2, 3, and 4 illustrate differences in temperatures in the several states, which may or may not mask symptoms, for each of the four years. An interpretation of the four-year averages is presented in figures 5 and 6, which illustrate the periods during the growing season when high temperatures favorable for masking occur. In Colorado the period of

masking is most likely to begin about the third week and continue throughout the entire growing season. The latter half of the growing season in Florida and Louisiana, from the tenth week on, favors masking. In Maine, New York, and Wisconsin, the second one-third of the season, from the fourth to the thirteenth week, is favorable for masking of the symptoms.

DISCUSSION OF RESULTS

It is believed that the experimental evidence presented establishes be-

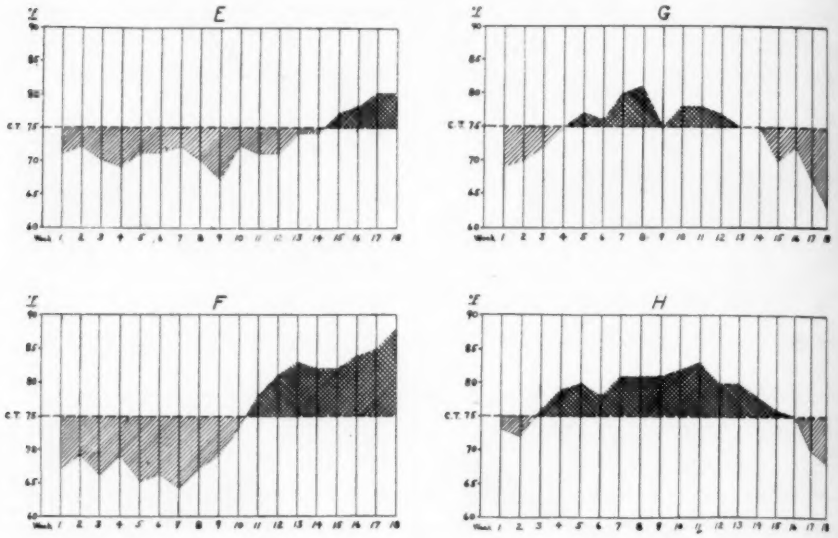

FIG. 6. Graphic representation, based on a 4-year average of maximum daily air temperatures, showing periods favorable for masking of symptoms in different potato-producing regions. E. St. Augustine, Florida. F. Baton Rouge, Louisiana. G. Orono, Maine. H. Medford, New York.

yond reasonable doubt that air temperature is the criterion which influences the presence or absence of the symptoms of potato mosaic and that such factors as soil temperature, soil moisture, humidity, light, and nutrition are of minor, if any, importance.

Relatively short intermittent exposures at air temperatures above the critical temperature (23° to 24° C.) are sufficient to induce masking of the symptoms, the rate of masking depending largely upon the length of exposure, upon the air temperature to which mosaic plants are exposed at or above the critical temperature, and upon the age of the leaves. The experimental results, therefore, indicate the importance and significance of the effect of relatively short periods of temperatures above 24° C. on mosaic,

especially when comparison is made between the data obtained under controlled conditions and that secured from official weather records.

The application in research and practice of the experimental results on intermittent exposures at high air temperatures is obvious. Experimental studies with mosaic should not be carried out without giving attention to the air temperatures at which they are performed. This is especially true in cross inoculation experiments and in studies on the influence of other environmental conditions or circumstances on the occurrence of mosaic.

The tuber-index method of eliminating mosaic from seedstock as described by Blodgett (1) will no doubt be used to an increasing extent. It is fundamental to this method that attention be given to the air temperature at which the potatoes are grown.

Of greater importance at present is the relationship which intermittent exposures at high air temperatures bear in general to seed potato inspection and certification work. At best, tuber indexing cannot be carried out on a large scale owing to the limited amount of available greenhouse space and to the relatively short period of time in which this type of work can be done, limited as it largely is to the winter months. Consequently the major part of the seed-improvement work must be done under a system of roguing in seedplots or in the commercial field. The success or failure of this method is directly dependent upon the daily variation in temperature. The possibility of great variation in several northern and western states with respect to periods favorable for the appearance of symptoms of potato mosaic has been suggested in a preceding chapter. In the West, the difficulties are apparently much greater than in the middle-western or eastern states, owing to periods of prolonged high air temperatures.

The effect of short exposures at high air temperatures on potato plants growing under field conditions also presents another aspect of general interest and one of much economic importance. The northern and western states which devote considerable acreage to the Triumph variety depend largely upon southern states as a market for seedstock. It has previously been shown that low air temperatures may predominate throughout the first half or more of the growing period in southern potato regions, with the result that the northern and western certified seed or other seedstock is put to a severe test in the average season. The southern grower is therefore naturally desirous of securing as healthy seed potatoes as possible from the seed-potato growing districts. In some seasons northern stock has apparently been entirely satisfactory, but, at other times, as a whole it has not. This may be due, in part at least, to seasonal differences in air temperatures which have been unfavorable for eliminating diseased stock in the North or which have been especially favorable for bringing out the symptoms in the South. In Louisiana and other southern areas, in the

spring of 1925, it has been estimated by experiment station officials that an average of 20 per cent of mosaic appeared in fields planted from certified stock, while the mosaic count in fields planted from common stock varied from 20 to 90 per cent. In consequence the yield of potatoes in the South is reduced considerably, and this in turn reflects on the market for the northern seed-potato producer. Reduction in the amount of mosaic in northern stock in the future will apparently depend largely upon the amount of seed which can be properly indexed under greenhouse conditions and the increase of this stock at suitable isolated places rather than upon roguing in the field, although it is recognized the latter method may always be a necessary adjunct.

SUMMARY

1. Studies have been made to determine the influence of air temperature, soil temperature and soil moisture, humidity, light, and nutrition on the symptoms of potato mosaic.

2. Air temperature was found to be the main and only factor affecting the amount and intensity of symptoms on potato foliage under greenhouse conditions.

3. Experiments conducted in constant air-control chambers indicated that relatively short exposures to air temperatures above that of the critical air temperature (23° to 24° C.) were sufficient to mask the symptoms of mosaic. The rate of masking was found to be dependent largely upon the duration of exposure, upon the air temperature to which exposed, and upon the age of the leaves.

4. Differences in air temperature accounted for marked variation in leaf area produced on mosaic plants exposed for the same length of time.

5. Masked mosaic plants subjected to low air temperatures always redeveloped characteristic symptoms of mosaic.

6. Symptoms of mosaic on the Triumph variety appeared in the field at a high altitude when air temperatures were favorable, but mottling was not as marked as under low altitude conditions.

7. High soil temperatures may be of importance in masking mosaic plants during the earlier stages of growth, regardless of the amount of moisture present in the soil, or air temperature favorable for the appearance of symptoms.

8. The effect of soil moisture, humidity, light, and variation in three essential elements for plant growth failed to decrease or intensify the symptoms of mosaic potato plants.

9. Histological studies indicated that masked leaves show marked deviation in structure from healthy leaves.

10. The time and duration of the period of masking varies in different potato-producing regions.

11. Intermittent air temperatures are of fundamental importance in connection with the tuber-index method for testing seed potatoes, in seed potato inspection and certification, and in experimental studies on mosaic.

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EXPLANATION OF PLATES

PLATE XXVIII

Representative leaves (B, C, D) from potato plants exposed for 15 hours at night to temperatures indicated, but remaining for 9 hours with controls (A and E) at about 15° C.

A. Mosaic control.
B. Mosaic leaf at 15° C. showing typical symptoms.
C. Mosaic leaf at 24° C. completely masked after 8 days.
D. Mosaic leaf at 28° C. completely masked after 8 days.
E. Healthy control.

Representative leaves (F, G, H) from potato plants exposed for 9 hours daily to temperatures indicated, but remaining for 15 hours with controls (A and E) at about 15° C.

F. Mosaic leaf at 15° C. showing typical symptoms.
G. Mosaic leaf at 24° C. partially masked after 7 days.
H. Mosaic leaf at 28° C. completely masked after 7 days.

PLATE XXIX

Representative leaves from potato plants exposed for 4 hours daily to temperatures indicated but remaining for 20 hours with control plants D and E at about 15° C.

A. Masking almost completed in mosaic leaf at 28° C. after 15 days.
B. Mosaic leaf at 24° C. with severe symptoms partially lacking.
C. Mosaic leaf at 15° C. showing typical symptoms.
D. Healthy control.
E. Mosaic control.

PLATE XXX

Representative mosaic potato plants exposed for 2 hours daily to temperatures indicated, but remaining for 22 hours with control plant D at about 15° C.

A. Mosaic plant at 15° C. showing typical symptoms.
B. Mosaic plant at 24° C. showing typical symptoms.
C. Mosaic plant at 28° C. almost completely masked after 25 days.
D. Mosaic control.

PLATE XXXI

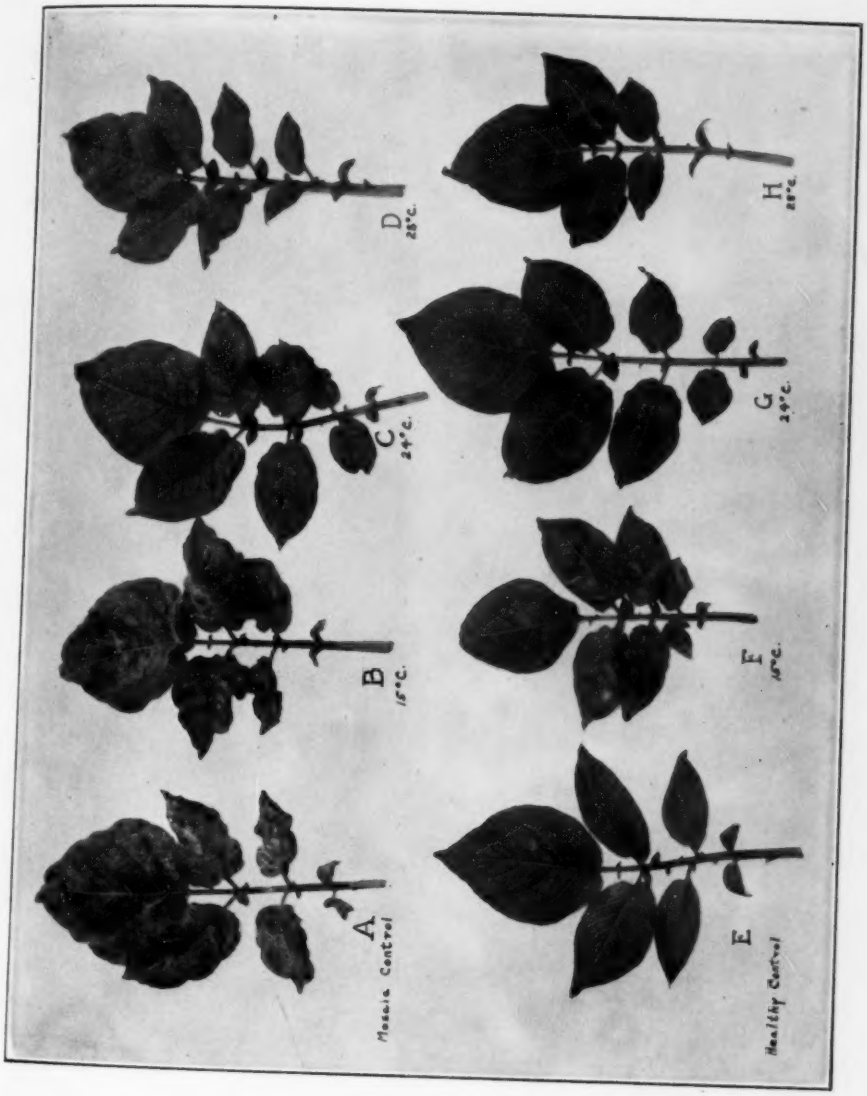
Representative mosaic potato plants exposed for 6 hours daily to temperatures indicated, but remaining for 18 hours with control plants A and B at about 15° C.

A. Healthy control.
B. Mosaic control.
C. Mosaic plant at 40° C. with symptoms masked after 6 days; decided stunting.
D. Mosaic plant at 30° C. with symptoms masked after 6 days.
E. Mosaic plant at 20° C. showing typical symptoms.

PLATE XXXII

Representative healthy and mosaic potato leaves from plants grown in soil temperatures indicated, but at air temperatures favorable for mosaic.

At 26° C.
A. Healthy leaf.
B. Mosaic leaf showing typical symptoms.
At 29° C.
C. Healthy leaf.
D. Mosaic leaf showing typical symptoms.
At 32° C.
E. Healthy leaf.
F. Mosaic leaf with symptoms completely masked after 18 days.
At 35° C.
G. Healthy leaf.
H. Mosaic leaf with symptoms completely masked after 18 days.


A
Mosaic Control
B
15°C.
C
24°C.
D
28°C.
E
Healthy Control
F
15°C.
G
24°C.
H
28°C.

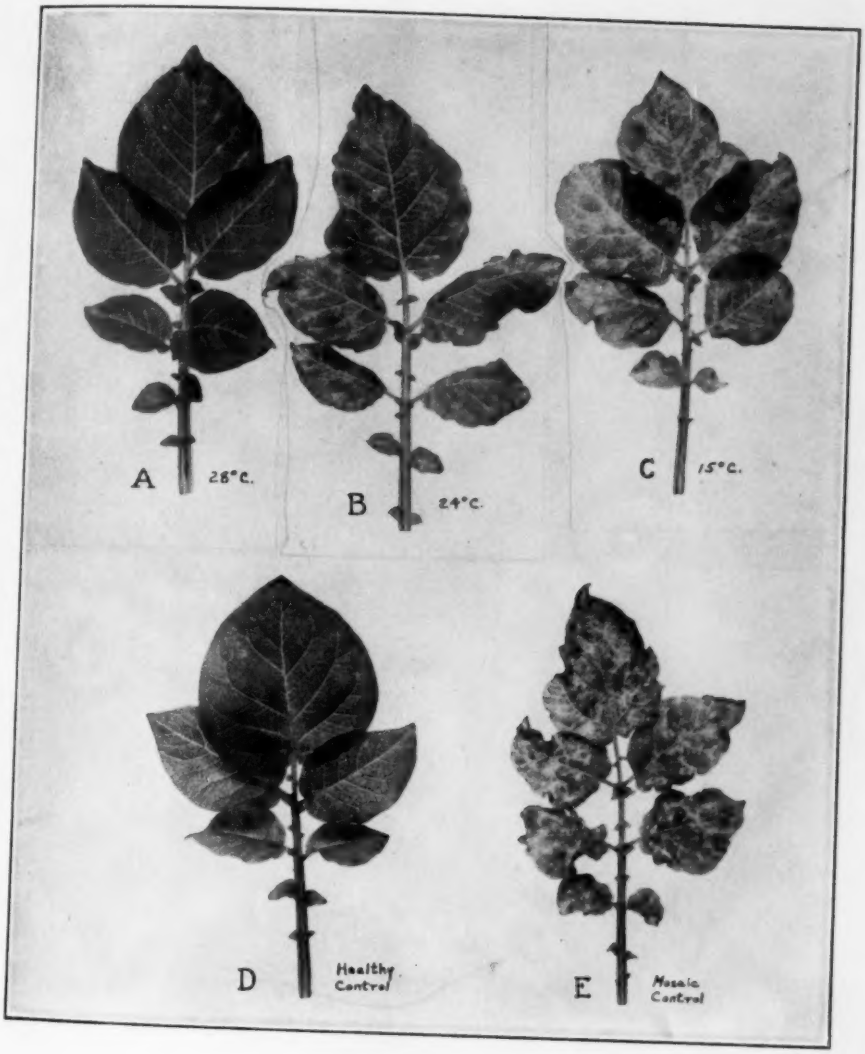

A
28°C.
B
24°C.
C
15°C.
D
Healthy
Control
E
Mosaic
Control

PLATE XXX

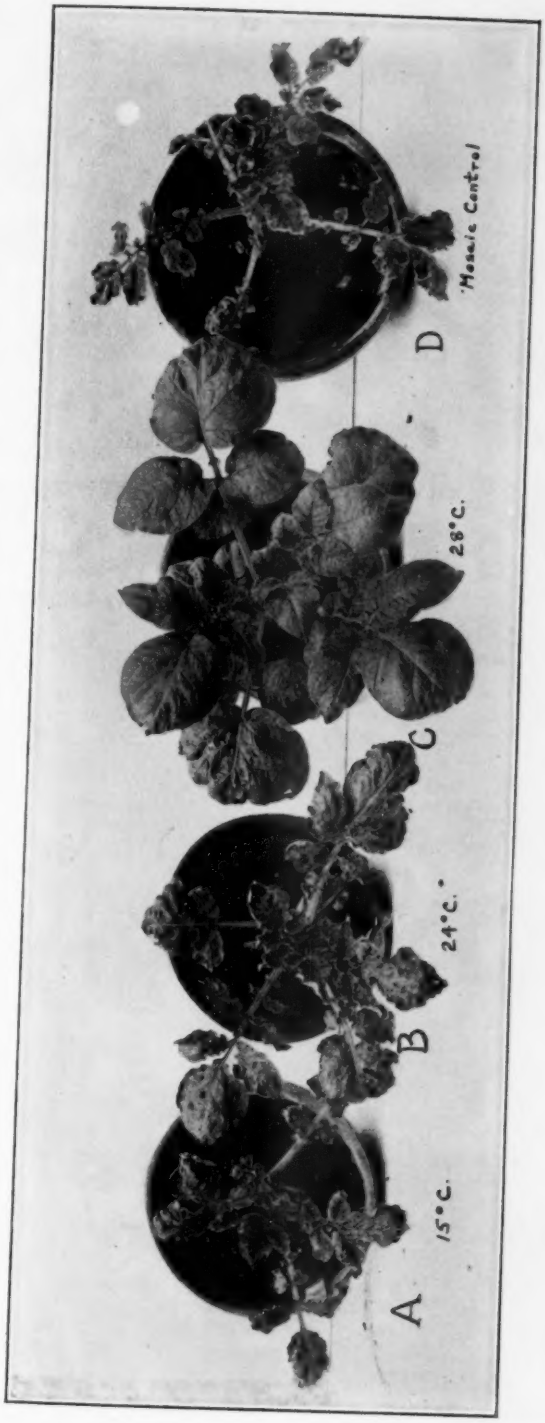
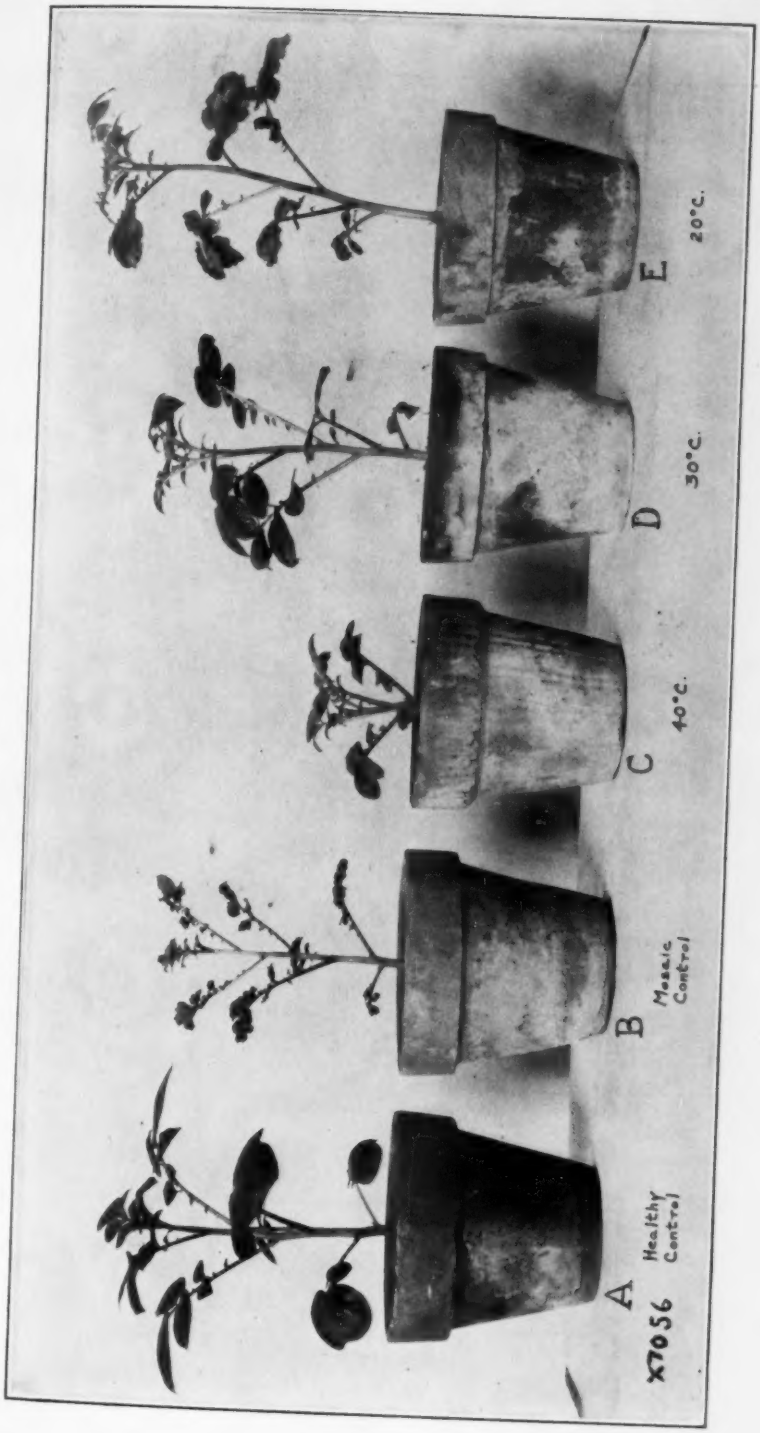
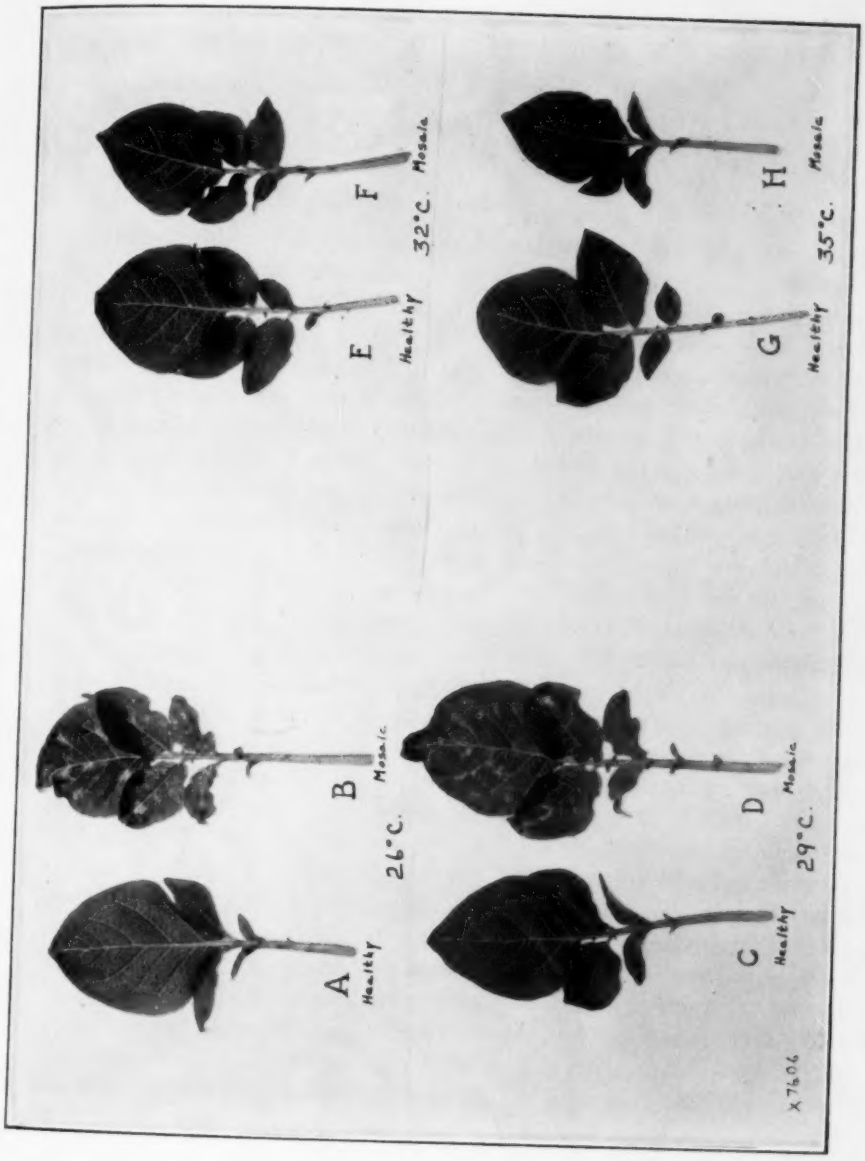


PLATE XXXI




A
Healthy
B
Mosaic
26°C.
C
Healthy
D
Mosaic
29°C.
E
Healthy
F
Mosaic
32°C.
G
Healthy
H
Mosaic
35°C.
x 7606

VERTICILLIUM-WILT OF MAPLE AND ELM-SEEDLINGS IN HOLLAND

JIKKE H. H. VAN DER MEER

ACER

Verticilliosis is described as a serious disease of several species of *Acer* in the United States of America and in Canada [Rankin (6), Zimm (7), Colley (4), Anonymous (1)]. According to Zimm (7), the isolated fungus appeared to be entirely different from *Verticillium albo-atrum* attacking potato. As he, and also Rankin (6), mentioned sclerotium-like bodies, it is highly probable that the fungus in question was *Verticillium dahliae* Kleb.

A case of Verticillium-wilt of maple was observed in Holland in 1919 by the Phytopathological Service, and the disease was attributed to *Verticillium albo-atrum* (2). In March, 1925, the Phytopathological Service, receiving some diseased young maples from another locality, sent one of the specimens to me. All isolations in this case gave *Verticillium dahliae* Kleb.

In September, 1925, the opportunity of studying maple-wilt more exactly offered itself. In the garden of a laboratory situated on the "Wageningsche Berg," where previously many cases of Verticilliosis, occurring in a great variety of hosts, were observed and described (5), two specimens of *Acer platanoides* L. var. *schwedleri*, about nine years old, suddenly showed the characteristic symptoms of wilting. One of the trees was photographed September 22 (Fig. 1). Five of the branches were dead, two were defoliated, five bore only a few leaves, and two had more normal foliage. In the part of the crown which was still living there were several dead lateral branches. The tree had produced very little new growth; the one-year-old shoots were generally 15–24 cm. and those of one branch were 40 cm. long. Four suckers had developed at the trunk, two of which bore wilting leaves. The north side of the trunk was flattened from the base to the top, the bark having died and ruptured longitudinally, especially where it touched the living tissue. Also at the other side of the tree, and at the bases of some branches, dead sunken areas were to be seen. The conidial stage of *Nectria cinnabarina* occurred here and there on the injuries. The canker already had been noticed the preceding year. The dead areas were then cut out and the wounds dressed with "carbolineum." No wonder that at the outset the gardener attributed the disease to *Nectria*. Being not quite sure of the diagnosis, he drew my attention to the trouble.

The tree was dug September 23 and studied in detail. The cross-sections of trunk, branches and roots (Pl. XXXIII, A) showed a characteristic discoloring of the wood; a central, irregular brown-green spot with a fringed dark-green edge, whereas stipples of the same color were found in the spring wood of the youngest annual rings. The internal symptoms resembled closely those of wilting cherry trees, except in the color of the diseased wood, which in the latter case was brown (5). The annual ring of 1925

FIG. 1. *Acer platanoides* L. var. *schwedleri* at Wageningen naturally infected with *Verticillium dahliae* Kleb. Photographed Sept. 22, 1925.

was much less well developed than the others and it failed completely at the above mentioned cankered spots (Plate XXXIII, A). The discoloration of the 1924 and 1925 annual rings could be followed in a longitudinal direction from the roots up to some two-year-old shoots. In one case a slight discoloration was still observed even in the current season's growth.

The trunk, the branches and the root, of which cross-sections are photographed, were subjected to cultural and microscopical examination. *Ver-*

ticillium dahliae Kleb. was isolated from the woody tissue of the three different parts of the tree. It grew out chiefly from the vessels of the 1925 annual ring. It appeared that a two-year-old shoot already contained the fungus, the new growth not yet being attacked.

Sections were made of the diseased wood, and a microscopic examination was made. The vascular walls were yellowed, and a gum-like substance was frequently noticed within the vessels. Radial sections were prepared from the remnants of those branch and root pieces from which *Verticillium dahliae* had been isolated. These sections were stained with Bleu cotton and the mycelium could be observed readily in the vessels. Microsclerotia mentioned by Rankin (6) were not found in the tracheae.

ULMUS

According to Versl. en Med. Phytopath. Dienst Wageningen (2) *Verticillium* was isolated from the branches of *Ulmus wheatlei,* the wood of which had brown stipples. The disease was also observed in *Ulmus campestris.*

Bewley (3) inoculated six young elm seedlings with *Verticillium* isolated from tomato. After four months they were shorter than the controls, but he did not observe any other symptoms.

In October, 1925, Verticilliosis developed very clearly among one-year-old seedlings of *Ulmus campestris* L. on an experimental plot situated on the "Wageningsche Berg." Miss Spierenburg, phytopathologist at Wageningen, isolated *Verticillium dahliae* and drew my attention to the disease. Previously potatoes had been grown on the field, which in this way had become infested with *Verticillium.*

Several specimens showed the typical yellow blotches on the leaves and the plants were stunted and partially defoliated. Five seedlings were dug and used for study.

On cross-sectioning roots, stems and branches, the characteristic browning of the wood was seen (Pl. XXXIII, B). The discoloration could be followed to the finest tips of some branches. *Verticillium dahliae* Kleb. was isolated from the roots, stems and branches, even from the top of a shoot.

Microscopical examination showed that the vascular walls were yellowed, and the vessels contained a gum-like substance and tyloses. By staining longitudinal sections of stem and root with Bleu cotton, mycelium was detected within the vessels.

SUMMARY

1. Verticilliosis, caused by *Verticillium dahliae,* was found on young trees of *Acer platanoides* var. *schwedleri,* and seedlings of *Ulmus campestris.*

2. The organism was isolated from roots, trunks, and branches of the infected plants.

3. The disease on maple is characterized by defoliation and death of branches, the production of suckers and cankers, and a brown-green discoloration of the wood. The elm seedlings are stunted and partially defoliated and the wood becomes brown.

4. Gum-like substances and mycelium were found in the vessels of diseased wood. There was a yellowish discoloration of the walls of the vascular elements.

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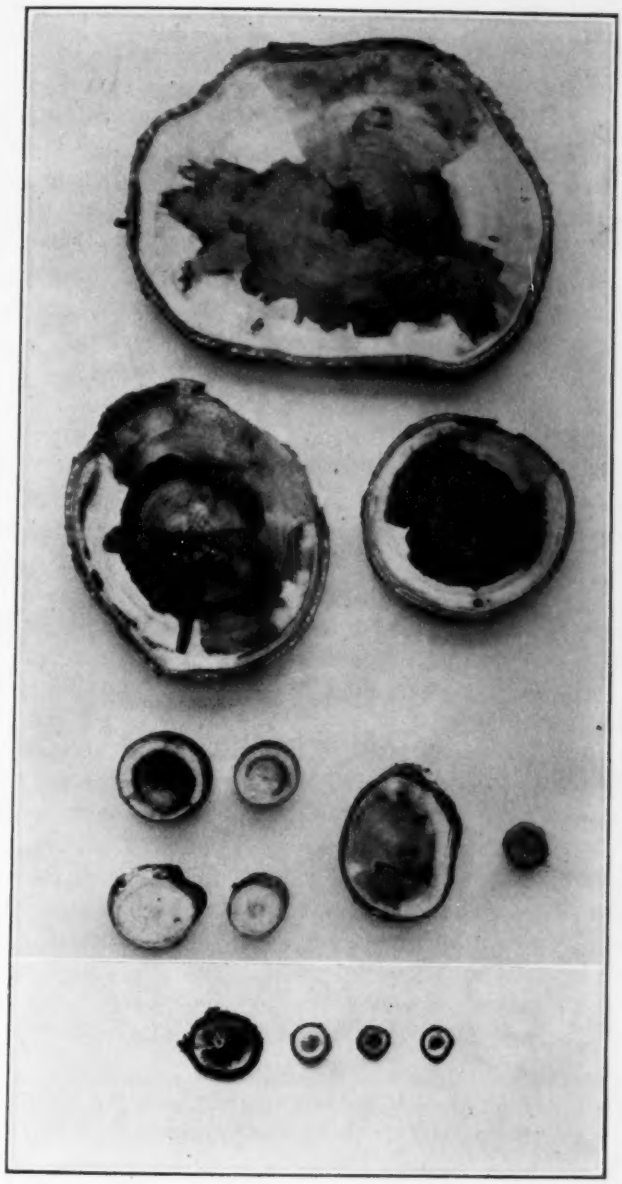
EXPLANATION OF PLATE XXXIII

A. Cross-sections of stem, branches and root of the maple represented in Fig. 1.

1a. The base of the stem.
1b. ± 95 cm. higher than 1a.
1c. ± 1.34 m. higher than 1b.
2a. The base of a branch. } dark-green stipples in 1925 annual ring
2b. ± 55 cm. higher. }
3a. The base of a branch. } do
3b. ± 25 cm. higher. }
4a. The base of a root.
4b. ± 35 cm. from the base.
Photographed Sept. 23, 1925.

B. Cross-sections of the stem and three branches of a one-year-old seedling of *Ulmus campestris* L. naturally infected with *Verticillium dahliae* Kleb. Photographed Oct. 14, 1925.


A
1a
1b
1c
2a b
3a b
4a b
B

THE CAUSE OF THE PERSISTENT DEVELOPMENT OF BASAL SHOOTS FROM BLIGHTED CHESTNUT TREES[1]

ARTHUR HARMOUNT GRAVES

In many places in the blight-devastated area of the American chestnut, the notion seems to have been gaining prevalence that the chestnut is "coming back"; since, frequently, where the main trunks have been killed off by the blight, vigorous shoots are seen to arise from the base of the tree. When these are killed by *Endothia parasitica*, as usually happens in a few years, fresh shoots appear, and successive generations of these basal sprouts may continue to develop for a long period. Cases are known to the writer where such crops of basal shoots have been periodically growing and dying for more than 15 years.[2] The vigor of these shoots, as well as the fact that they appear so persistently after the supposed death of the tree, has doubtless given rise to the popular belief in a general resurrection of the chestnut.

As an explanation of this apparent rehabilitation, it would seem indicated *a priori* that the tissues of the root collar (*i.e.*, the part of the tree where root and trunk unite), and of the roots of the chestnut, are more resistant to the growth of the fungus than the parts above ground. For when the fungus reaches these basal parts after killing the trunk above, it apparently grows more slowly, giving time for adventitious buds to develop, and, nourished by the still healthy roots of the old tree, to form vigorous young shoots. In order to test out this hypothesis, it was determined to get some definite data on the comparative resistance of root and stem tissues. For this purpose inoculations of healthy roots and basal shoots of blighted trees were made in August, 1924, at Hamden and at West Hartford, Connecticut. The inoculum used was a pure culture of *Endothia parasitica* isolated from a dying tree at West Hartford, Connecticut. All inoculations, whether on root or shoot, were covered immediately with white adhesive tape. Immediately after the roots were inoculated they were covered, in some cases with dead leaves, on which the original earth was piled but not packed down; in other cases the earth was replaced directly on the roots. On inspection one year later, no difference in the rate of

[1] Investigations carried on by the Brooklyn Botanic Garden in cooperation with the Office of Investigations in Forest Pathology, Bureau of Plant Industry, United States Department of Agriculture. Brooklyn Botanic Garden Contributions No. 47.

[2] As a matter of fact, the condition is not quite so simple as this. Fresh shoots may appear each year, and at the same time older ones may die out, so that we do not usually find a well-defined series of crops.

growth of the fungus was noted as a result of these two methods of treatment.

The results of the inoculations after one year's growth of the fungus are given in table 1. A general inspection of table 1 shows at once that the fungus grew much more slowly in the roots than in the shoots. In fact its growth in many of the inoculated roots is surprisingly small. In every case, however, inspection showed the mycelium to be present in the bark near the inoculation slit, and in one case (No. 20) a small root had been girdled, showing the fruiting pustules of the fungus. Where the lateral growth of the fungus was less than 0.4 mm, it was classed as "slight."

An interesting feature of the inoculated roots was the sunken character of the lesion. In other work by the writer on resistant chestnut (6), hypertrophy of the host tissue in the region of the lesion, at least in the parts above ground, has been noted as a common occurrence. The writer is unable to offer any explanation for the opposite effect in the root tissue, except that the rate of growth of the root tissue may be comparatively slow. A fact that may have some relation to this behavior is that in many cases the mycelium of the fungus had invaded the outer root bark only, the inner bark tissues being white and sound.

The shoots were all girdled without exception, and, of course, where they were small, the circumference of the stem does not represent the limit of the potential growth of the fungus. Nos. 27–29, however, very closely approximated the average annual lateral growth of the fungus as given by Anderson and Rankin (1) (15.97 cm.) for Charter Oak, Penn.; by Rogers and Gravatt (7) (16.13 cm.) for Bluemont, Va.; and by Stevens (8) (16 cm.) for Hartford, Conn.

The following roots and shoots of approximately equal circumference may be compared; nos. 30 and 31 of the shoots with nos. 1, 29, and 36 of the roots; nos. 10, 17, 18, 19, and 24 of the shoots with no. 34 of roots; and nos. 25 and 26 of the shoots with nos. 2, 3, 7, 8, 10, and 11 of the roots.

The cause of the greater resistance of the root tissue may be due, at least in part, to the presence of some substance or substances which are either lacking in the shoots or present in smaller quantities than in other parts of the tree. It is possible that these substances are tannin compounds or substances associated with tannin, which it has been demonstrated experimentally (2, 4, 5) have an inhibitory effect on the growth of the fungus, when above a certain concentration. That the roots of the chestnut contain a much higher tannin content than the trunk has been shown by recent studies of the Leather and Paper Laboratory of the Bureau of Chemistry,[3]

[3] Unpublished paper entitled "The distribution of tannin in the American chestnut tree. Utilization of chestnut stumps." Leather and Paper Laboratory, Bur. of Chemistry, U. S. Dept. Agr.

TABLE 1.—*Comparative growth of Endothia parasitica (Murr.) And. in roots and shoots of Castanea dentata for one year ending August 8–10, 1925*

No. of tree[a]	Shoot inoculations			Root inoculations		
	Inoculation number	Circumference of shoot in cm. at region of inoculation	Lateral growth of fungus	Inoculation number	Circumference of root in cm. at region of inoculation	Lateral growth of fungus in cm.
I	1	3.7	girdled	1	13.8	slight
	2	3.7	do	2	11.6	do
	3	4.7	do	3	10.1	3.0
	4	4.4	do	4	8.8	slight
	5	3.7	do	5	8.8	4.0
	6	4.4	do	6	Main trunk root	4.0
	7	3.7	do	7	11.6	1.0
	8	3.5	do	8	11.6	slight
II	9	5.3	do	9	8.8	2.2
	10	2.5	do			
III	11	3.7	do	10	11.0	1.5
	12	3.7	do	11	11.0	2.0
				12	8.8	1.5
				13	6.9	1.6
				14	7.9	1.8
IV	13	4.7	do	15	7.9	2.5
	14	4.7	do	16	8.8	1.2
	15	3.7	do	17	7.9	0.8
	16	3.7	do	18	28.0	1.7
	17	2.5	do	19	31.7	2.3
V	18	2.8	do	20	1.6	girdled
	19	2.5	do	21	1.6	slight
				22	1.6	0.4
				23	1.6	0.4
				24	7.9	0.4
				25	7.9	0.8
				26	1.6	slight
VI	20	4.7	do	27	23.9	1.4
	21	2.7	do	28	23.9	1.2
	22	4.0	do			
	23	4.0	do			

TABLE 1.—*Continued.*

No. of trees[a]	Shoot inoculations			Root inoculations		
	Inoculation number	Circumference of shoot in cm. at region of inoculation	Lateral growth of fungus	Inoculation number	Circumference of root in cm. at region of inoculation	Lateral growth of fungus in cm.
VII	24	2.5	girdled	29	13.8	4.0
				30	13.8	slight
VIII				31	7.9	do
				32	8.8	do
	25	10.4	do	33	8.8	do
	26	10.0	do	34	2.5	do
				35	21.0	do
				36	13.8	do
IX	27	17.0	do			
	28	16.0	do	37	Large main root	0.4
	29	15.4	do			
	30	14.5	do	38	22.0	2.8
	31	14.5	do	39	22.0	1.7

[a] Nos. I–VII, Hamden, Conn.; nos. VIII–IX, West Hartford, Conn.

and also by analyses made in the same laboratory in cooperation with this office. In particular, the bark of chestnut roots is found to be high in tannin, containing, in the samples analyzed, more than twice the amount found in the bark of the trunk.

After a careful study of all stages of these basal shoots, their life history appears to be about as follows: during and after the death of the trunk, adventitious buds, which are normally abundantly present in the root collar of the chestnut, begin to develop into shoots, utilizing the main root of the tree, which still may be healthy in certain parts, for their support from the soil. But very soon small new roots develop at the base of these shoots. Where the adventitious buds were a few inches above the ground, I have found aerial roots growing down toward the soil, but in most cases the buds are located far enough down so that the roots start in the soil. In time, as the root of the old tree dies, these new roots become larger and eventually become the sole support of the shoot (Fig. 1). Sooner or later, however, the blight appears—usually at the ground level—ending the life of this particular shoot.

In the meantime, the shoots, if not diseased above, may have lived 4, 5 or 6, or even more years; and I have seen them 20 feet high, in some cases

FIG. 1. Basal shoots with their new roots from the region of the root collar of an old chestnut stump. The part of the stump above the shoots has been dead at least 10 years. Lying across the top of the stump is a part of a dead shoot belonging to a former generation of sprouts. The shoot to the extreme right is also now dead.

bearing catkins and maturing nuts. In the interim other shoots have been developing from adventitious buds on the old stump. After the death from Endothia infection of a large shoot with correspondingly well developed independent roots, new shoots may develop from adventitious buds at the new root collar belonging to this shoot. This condition occurs frequently.

How long will this state of affairs continue? Evidently not indefinitely, for the root tissue, although more resistant than the stem tissue, slowly succumbs to the attack of the parasite. In the great majority of trees it is already at an end, roots as well as shoots being entirely dead.

And yet the possibilities along this line must not be overlooked. If the resistant substances, whatever they may be, should at any time develop sufficient concentration to obstruct the progress of the fungus—or if, on the other hand, the parasite should lose some of its virulence—a way out of the present difficulty appears. Collins (3) already has noted a case where sprouts successfully threw off the invading fungus for at least seven years, apparently occluding the original lesion. We should be on the lookout for similar cases.

In the meantime we must rejoice in the fact that the chestnut has already revealed, in another direction, an asset of tremendous value. I refer to the observation, already mentioned, that some of these shoots are bearing catkins and mature nuts.

The power of sexual reproduction through seed, borne on these basal shoots, should enable the species to postpone its possible extinction still farther. Since such seed might contain valuable qualities, it should be carefully gathered and planted.

SUMMARY

1. Comparative inoculations on roots and shoots of the American chestnut have demonstrated that the root tissues, including the region of the root collar, are far more resistant to the growth of *Endothia parasitica* than are the stem tissues. In view of previous work indicating an inhibitory effect of tannin on the growth of fungi, it is suggested that the greater resistance of the root tissues may be due, at least in part, to their greater content of tannin compounds or of substances associated with tannin.

2. The greater resistance of the root and root collar tissues is obviously the cause of repeated generations of sprouts from blighted trees. The shoots develop from adventitious buds in the region of the root collar, utilizing at first the root of the old tree, but in time developing their own roots. Ordinarily these shoots die of the blight, but others may have appeared in the meantime, and in this way a succession of "crops" is developed. A further fact of great significance is that many of these shoots have already been found maturing nuts.

These two conditions, namely, the continued development of shoots, and the bearing of seed by these shoots, are most valuable assets to the chestnut, since they may extend the lease of life of the species. In the meantime, variations of parasite or host, favorable to the latter, may occur. Seed of these shoots should be carefully gathered and planted.

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SPECIES OF NECTRIA, GIBBERELLA, FUSARIUM, CYLINDROCARPON AND RAMULARIA OCCURRING ON THE BARK OF PYRUS SPP. IN OREGON

S. M. Zeller

In connection with a study of European canker of pomaceous fruit trees,[1] the writer has collected or received for identification for several years occasional lots of material suspected as the ascogenous or conidial form of *Nectria galligena* Bres. or closely related species. It was thought well to list, with some notes, this group of species of Ascomycetes and Fungi Imperfecti which are closely linked in the taxonomic literature. The identification of most of the species has been verified by Dr. H. W. Wollenweber, and one new species described by him is listed.

NECTRIA

1. *Nectria cinnabarina* (Tode) Fr.

This fungus is found to a considerable extent on pear twigs which have died back from various causes. After this start in a saprophytic condition, it becomes a means of considerable destruction in living bark, which, although temporarily somewhat devitalized by low temperatures, would doubtless otherwise regain its vigor. *N. cinnabarina* also infects cankered areas on larger branches, especially attacking the spongy parenchyma surrounding lesions produced by the woolly aphis, *Eriosoma pyricola*.

2. *Nectria galligena* Bres.

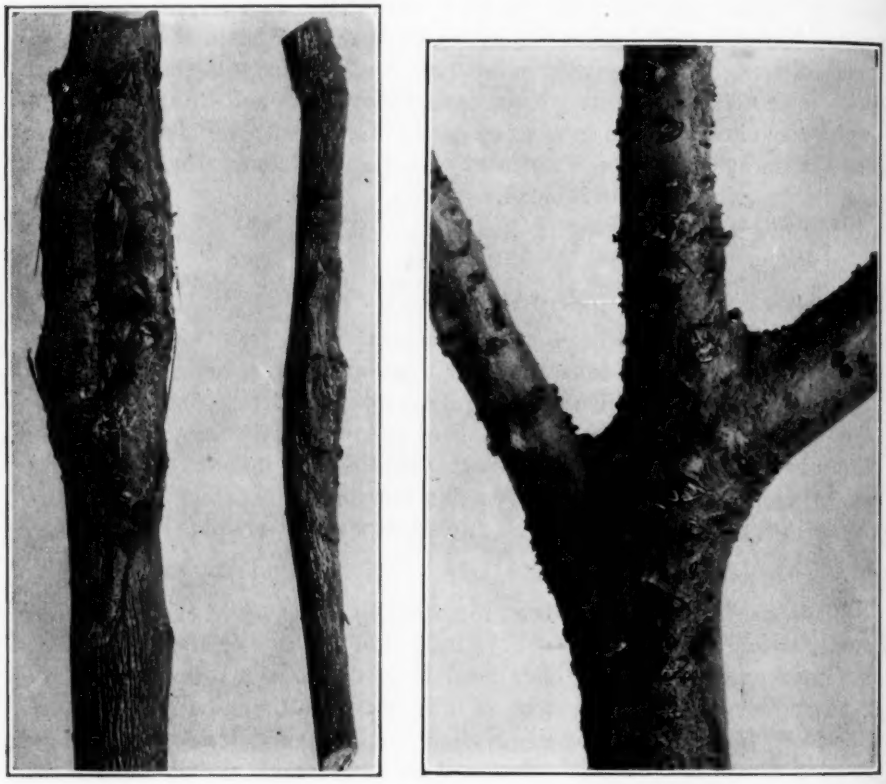
This species has already been reported[2] as the cause of canker of apple and pear on the Pacific Slope. The control of this canker and its peculiarities as found in America have been fully discussed by the writer in a monographic study.[1] The stage of this fungus represented by *Cylindrocarpon mali* (All.) Wr. is more often found than the ascogenous stage. Pear trees are more severely damaged in the western coastal orchard districts than are the apple trees, because the apples are often protected by the summer application of bordeaux mixture (4–4–50) for the control of apple-tree anthracnose (*Neofabraea malicorticis*).

[1] Zeller, S. M. The European canker of pomaceous fruit trees. Ore. Agr. Exp. Sta. Bul. 222. 1926.

[2] Zeller, S. M., and C. E. Owens. European canker on the Pacific Slope. Phytopathology 11: 464–468. 1921.

3. *Nectria sanguinea* (Sibth.) Fr.

This is the most common species of the section Willkommiotes Wr. which grows saprophytically on a wide range of woody hosts in Oregon. It has been found on apple bark only once. In this case the macroconidia (*Cylindrocarpon*), which were found in large quantities in the crevices of the bark surrounding the sporodochia, were conjugating as shown in figure 2. Some comparatively long conjugating tubes were observed, connecting cells of one spore with those of another. In all cases the nucleus had migrated



a b

FIG. 1.—a. Cankers of apple invaded by *Gibberella baccata* (Wallr.) Sacc.
b. Sporodochia of *Fusarium oxysporum* Schlecht., breaking through the epidermis of apple bark.

from one cell to the other, producing a binucleate condition previously reported by the writer and Cayley[3] as a condition not uncommonly found in *Nectria galligena* Bres. Another conjugation of cells occurs between two cells of the same spore. This has somewhat the appearance of clamp-con-

[3] Cayley, Dorothy M. Some observations on the life history of *Nectria galligena* Bres. Ann. Bot. 35: 79–92. 1921.

nections in Basidiomycetes but results in more of an open medallion appearance. In these cases of conjugation of cells, the binucleate condition results.

Fusarium avenaceum (Fr.) Sacc. was found associated with the Cylindrocarpon stage of *Nectria sanguinea* on apple bark.

GIBBERELLA

4. *Giberella baccata* (Wallr.) Sacc.

The conidial stage (*Fusarium lateritium* Nees) was found fruiting on small cankers sent to the writer from Cascade Locks, Oregon. These are illustrated in figure 1, a. It would appear that the infection starts at leaf scars, in the buds of small twigs, or in lesions produced by the woolly aphis. These enlarge, producing the open type of canker illustrated. Woolly aphids have undoubtedly stimulated the callus formation in some cases. The sporodochia break through the epidermis of the bark as brick-red pustules about one mm. in diameter. In the illustration these are seen as black spots on the callus tissue.

5. *Gibberella moricola* (Ces. & Not.) Sacc.

G. moricola was found growing saprophytically on reddish, sun scalded bark of apple branches. The fungus was limited to a small area of the blistered epidermis. The material shows both the perithecia and the conidial form, *Fusarium urticacearum* (Cda.) Sacc.

FUSARIUM

6. *Fusarium acuminatum* Ell. and Ev. em. Wr.

Found growing saprophytically on die-back branches of Anjou pear and following woolly aphis injury on apple in the vicinity of Corvallis. Also found on apple bark from Walla Walla, Washington.

7. *Fusarium bulbigenum* Cooke and Harkn.

Under winter injured apple bark, Corvallis. May.

8. *Fusarium graminum* Cda.

Professor H. P. Barss collected this species on bark from an apple canker at the base of the trunk of a small tree, Clatsop County, August, 1922.

9. *Fusarium herbarum* (Cda.) Fr.

On pear bark, Grants Pass and Colton. April and June.

10. *Fusarium oxysporum* Schlecht.

Two young apple trees which had suffered apparent winter injury were completely covered above the main crotch, with the sporodochia bursting through the epidermis as illustrated in figure 1, b. Branches were infected for distances of 4 or 5 feet. Material was sent to Dr. Wollenweber who

states that this is the first report of the occurrence of *F. oxysporum* on apple trees. His notes on the cultural characters of this strain from apple bark follow:

"The fungus developed terminal chlamydospores and all other types of this resting stage in abundance in pure culture. . . . It develops large but few sporodochia covered by ochraceous to pale salmon-colored conidial masses. Blue sclerotia or sclerotial plectenchyma of medium to large size up to 3 mm. occur on potato tuber plugs. On rice the color is lilac rosy, turning blue by addition of sufficient alkali. The conidia have the shape of *F. oxysporum* Schlecht., and at any rate, if it is not identical with this species, it is not far off."

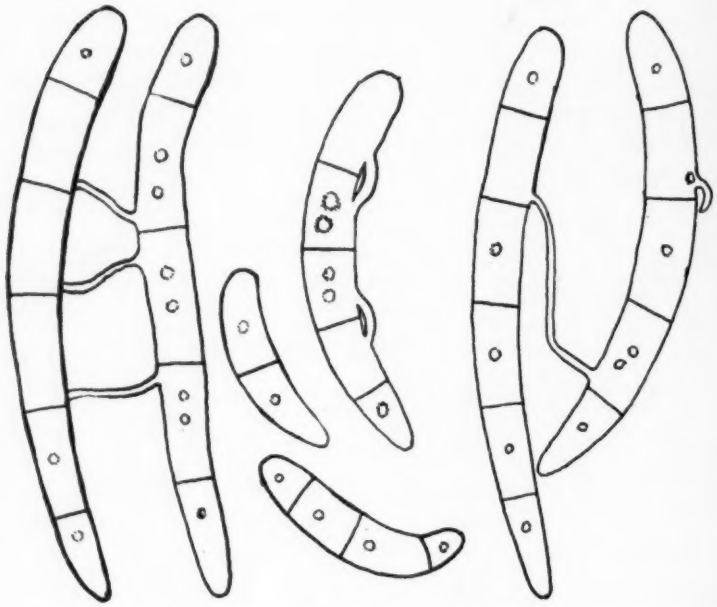


FIG. 2. Macroconidia of *Nectria sanguinea* (Sibth.) Fries, showing the peculiar conjugation of cells when these spores are lodged in masses in the crevices of bark. ×1,000.

The collections were made by the writer and F. M. Green at Hood River, November, 1922, and again in Corvallis, July, 1925.

11. *Fusarium polymorphum* Matr.

On pear bark, Grants Pass, April 24, 1924. Found to be associated with *F. herbarum* and *Ramularia obtusispora* in the same piece of bark.

Although not reported from Oregon, *Fusarium equiseti* (Cda.) Sacc. was received from San Jose, California, on pear bark.

CYLINDROCARPON

Besides the species of *Cylindrocarpon* which are definitely known to represent the macroconidial forms of species of *Nectria*, one other species has been found in Oregon. This species proved to be undescribed and the diagnosis by Dr. Wollenweber appears below.

12. **Cylindrocarpon angustum** Wollenweber sp. nov.

Sporodochiis tubercularibus, ad basim plectenchymicis, plus minusve erumpentibus, isabellinis vel incarnatis; conidiis cylindratis, rectis vel leniter curvatis, utrinque obtusis, 5-septatis, 57–81 × 3–4 mier., rarioribus 3-, 4-, 6-, rarissime 7-septatis; 6–7-septatis, 69–92 × 3.5–4 mier. Chlamydospora non visa sunt.

Habitat: In rimis corticis Piri mali, Clatsop County, Oregon. Amer. borealis, autumnos 1922 leg. H. P. Barss (in Ore. Agr. Col. Herb. no. 4849 et Wollenweber Herb.).

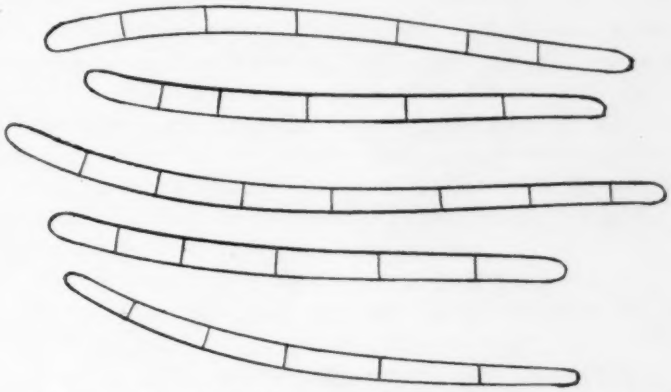


FIG. 3. Macroconidia of *Cylindrocarpon angustum* Wollenw., n. sp. × 1,000.

Figure 3 illustrates the outline of the macroconidia (× 1,000) of *C. angustum*. The macronidia are strikingly smaller in diameter than those of congeneric species.

RAMULARIA

13. *Ramularia obtusispora* (Cke. and Hark.) Wr.

On pear bark, Forest Grove and Grants Pass, April and May. As mentioned above the collection of this species found at Grants Pass was associated with *Fusarium polymorphum* and *F. herbarum*.

OREGON EXPERIMENT STATION,
CORVALLIS, OREGON.

EFFECTS OF WHEAT TREATED WITH COPPER CARBONATE UPON THE COMMON HOUSE MOUSE (*MUS MUSCULUS*)

W. W. Mackie[1] and Fred N. Briggs[2]

Copper carbonate dust applied to seed wheat for bunt control has been found to prevent insect attack in stored grain,[3] and it has been repeatedly observed by the writers that seed wheat thus treated was not attacked by mice. In order to determine whether copper carbonate dust is poisonous to mice or acts solely as a repellant, a series of experiments were conducted in which wild mice were fed in strict confinement.

On August 4, 1925, two adult and five half grown mice were trapped in the agronomy storage room. These were placed in cages 12 inches square. They were confined for one month on a pure wheat diet before the experiments with treated wheat were started. All of the young mice soon developed rickets and two of them were killed because of the severity of the attack. On the addition of a few drops of cod liver oil to the diet each week, the disease soon disappeared and did not occur again. Later one adult mouse escaped, leaving four mice with which to start the experiments. The amount of wheat eaten by the various mice was carefully weighed for a period of one week. The adult mouse ate approximately 5.0 grams of wheat daily and the others about 3.5 grams each per day.

Each mouse was kept in a separate cage and was given clean bedding once each week. The cages were numbered I, II, III, and IV; the adult mouse occupying number III. Beginning September 4, 1925, numbers III and IV were given wheat treated with copper carbonate at the rate of one ounce per bushel, while numbers I and II served as checks. The treated wheat was eaten just as readily as the untreated wheat and approximately in the same quantities without any apparent ill effects at the end of the seven-day period.

All the mice were then put on the untreated wheat ration for a week. Thereafter the mice in cages III and IV were fed wheat treated with copper carbonate at the rate of two ounces per bushel, while numbers I and II again served as checks. Later, numbers III and IV were fed for a week on

[1] Associate Agronomist, in charge of Cereal Investigations, California Agricultural Experiment Station.

[2] Assistant Pathologist, Office of Cereal Investigations, Bureau of Plant Industry, United States Department of Agriculture.

[3] Mackie, W. W. Prevention of insect attack on stored grain. Calif. Agr. Exp. Sta. Circ. 282. 1–8. 1925.

wheat treated with copper carbonate at the rate of four ounces per bushel. In both instances they ate the wheat in normal amounts, without apparently suffering any ill effects.

After another week of a ration of untreated wheat, all four mice were fed for 15 days with wheat treated with copper carbonate at the rate of four ounces per bushel, without ill effects.

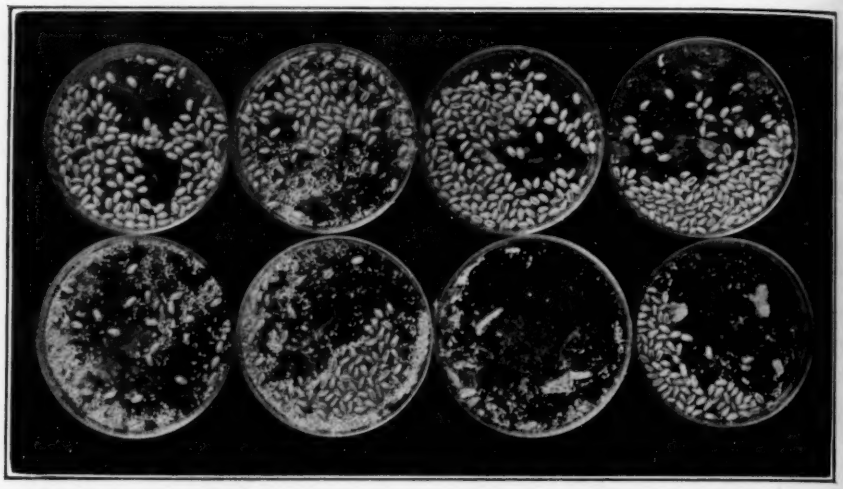


FIG. 1. The petri dishes in the top row contain wheat treated with copper carbonate dust at the rate of one ounce per bushel. Those in the bottom row contain untreated wheat. Each dish originally contained 10 grams of wheat, and the photograph was made after 48 hours of feeding. Only the treated seed in dish No. 2 has been eaten appreciably.

When it was apparent that the mice would not be readily killed by eating treated wheat, another experiment was started in order to determine if they would choose between treated and untreated wheat. Two dishes of wheat were placed in each cage, one containing wheat treated with copper carbonate at the rate of one ounce per bushel and one with untreated wheat. Figure 1 shows the dishes with the wheat remaining after two days. Number II was the only mouse that ate the treated wheat to any extent. The experiment was repeated with wheat dusted with two ounces of copper carbonate per bushel. Following this treatment none of the mice ate the treated wheat (Fig. 2).

DISCUSSION

Mackie[4] has shown that wheat treated with copper carbonate dust is free from weevil injury as contact with the dust kills the weevil. Hoffman and

[4] Mackie, W. W. *Loc. cit.*

Belton[5] state that "the treated grain is poisonous to live stock of all kinds as well as to rodents." However, they do not give any data on this subject. There is no doubt that copper carbonate is poisonous and therefore should be handled with some care. Data presented here indicate that mice do not get enough copper when fed in the copper carbonate form to injure them when fed only treated wheat, even when the rate of treatment is four ounces per bushel or twice as much as ordinarily is used on the farm. If a mouse

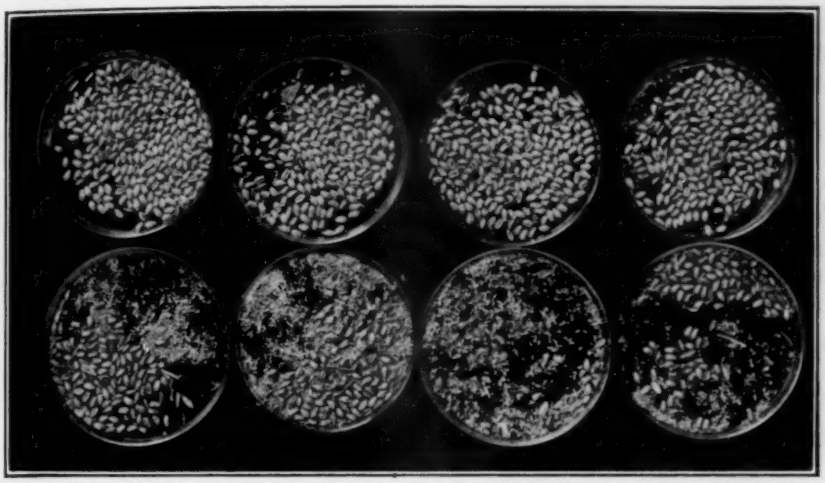


FIG. 2. The dishes in the top row contained wheat treated with copper carbonate at the rate of two ounces per bushel. The dishes in the bottom row contain untreated wheat. Each dish originally contained 10 grams and was photographed after 48 hours of feeding. The treated seed is scarcely touched.

which consumes five grams of wheat per day ate all of the copper carbonate on the wheat, he would consume only .0208 grams per day; but a mouse leaves most of the chaff in eating wheat and in so doing avoids most of the copper carbonate.

SUMMARY

Copper carbonate causes no apparent injury to mice when consumed by them on wheat as ordinarily treated to control bunt.

When untreated wheat is available mice will avoid wheat treated with copper carbonate.

So far as the effect upon mice is concerned, copper carbonate is a repellant and not a poison.

[5] Hoffman, A. H., and H. H. Belton. Machines for coating seed wheat with copper carbonate dust. Calif. Agr. Exp. Sta. Bul. 391. 1–16. 1925.

An adult mouse may consume approximately 1/3 of a pound of wheat per month and a half-grown mouse about 1/4 of a pound per month.

Because of the mouse-repellant action of copper carbonate dust, treated seed wheat may be stored exposed to mice for indefinite periods awaiting its final use. Under ordinary farm conditions, this action of copper carbonate dust will save farmers great quantities of valuable seed.

INJURY TO GLASSHOUSE PLANTS FROM HYDROCYANIC ACID GAS, FOLLOWING THE APPLICATION OF COPPER FUNGICIDES

E. F. Guba

It is known among citrus growers in California and Florida that the fumigation of citrus trees with hydrocyanic acid gas following the application of bordeaux mixture is accompanied by serious injury to the trees. The injury is manifested in the form of browning of the leaves and defoliation, often accompanied by severe pitting of the fruit. In some cases injury has resulted as late as 11 months after the copper spray was applied, although ordinarily little if any injury occurs six months after spraying. To avoid this injury where brown rot and other diseases are to be controlled, some growers have adopted the practice of spraying two or three days after fumigation, while others have discontinued the use of bordeaux entirely in favor of other fungicidal preparations free of copper.[1]

The writer is not aware of any literature, popular or otherwise, offering any objections to the use of copper fungicides in greenhouses. However, many greenhouse men, not knowing of the incompatability of copper fungicides and hydrocyanic acid gas, used in the order given, have lost entire houses of tomatoes and cucumbers in the very height of picking. In the majority of cases the injury has been attributed to overdosage of cyanide, over-exposure, or other conditions under which fumigation took place. Rarely has injury been associated with the presence of copper fungicides on the plants.

Hydrocyanic acid gas is a very effective fumigant for killing certain greenhouse insects. It is obtained from the action between sodium or potassium cyanide and sulfuric acid, or between calcium cyanide and water. With the presence of copper fungicides on the foliage, the hydrocyanic acid gas liberated combines with the copper to form cupric cyanide $Cu(CN)_2$, a very poisonous and unstable compound giving off cyanogen and leaving cuprous cyanide $Cu(CN)$.[2,3] In trials conducted in the greenhouse on cucumber and tomato plants treated with bordeaux, pyrox and copper lime

[1] Woglum, R. S. Fumigation of citrus trees for control of insect pests. U. S. D. A. Farmers' Bulletin 1321. 1923.

[2] Turner, F. M., et al. The condensed chemical dictionary. The Chemical Catalog Co., Inc., N. Y. 525 pp. 1919.

[3] Bloxam, C. L. Chemistry, inorganic and organic with experiments. 11th ed. rev. P. Blakiston's Son and Co., Philadelphia. 1923.

dust, all plants were injured equally following fumigation with hydrocyanic acid gas, while plants not treated with copper fungicides but exposed to the fumigant were unaffected. No data have been obtained to indicate how long after the application of copper the houses may be fumigated without danger of injuring the plants, although we have record of an instance of no injury from fumigation with calcium cyanide 46 days after the copper treatment.

Since hydrocyanic acid gas is used by the majority of growers for the control of certain insects affecting greenhouse plants, it is very essential that any recommendations for the control of fungous diseases involving the use of bordeaux mixture or copper lime dust should be accompanied by a word of warning. Where fungous diseases are of sufficient economic importance in the greenhouse to warrant the use of copper fungicides, the cyanide fumigant should always precede the application of the copper by one or two days, or the use of cyanide should be abandoned in favor of tobacco fumigants. Under any conditions cyanide fumigation should never immediately follow the use of copper.

DEPARTMENT OF BOTANY,
MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

NEGATIVE RESULTS OBTAINED BY THE USE OF PARADICHLOROBENZENE AGAINST THE ROOT-NEMATODE, HETERODERA RADICICOLA

H. R. Rosen

The successful control of peach tree borers obtained by applying paradichlorobenzene to the soil is now well known. Though this remedy is of comparatively recent development, it has very largely, if not entirely, replaced the old laborious digging-out method. The chemical is easily applied and costs but a few cents a tree.

In view of these facts, and in view of the killing of the insect by the gas liberated in the soil, it seemed desirable to ascertain the action of the same chemical against another soil-inhabiting metazoan, the common root-nematode, *Heterodera radicicola*. Two lots of sandy soil were obtained, one in which the nematodes had been so abundant as to completely prevent the development of marketable sweet potato roots, and the other one in which tomato roots had been severely infested. Both soils had been under close observation by the writer, and the effects on the roots were noted during the growing season of 1925 up until October. In each instance the soil gathered represented portions in which infested roots were common. Sufficient soil of each type was obtained on November 17, 1925, to fill three pots, each 6 inches in diameter. Three pots, two of soil in which the tomatoes had grown, and one in which the sweet potatoes had grown, received 0.25 ounces of paradichlorobenzene per pot. The chemical was applied in the center of the pot, about 2 inches below the surface. The other three pots, untreated, served as checks. Tomato seed, of a wilt-resistant Stone variety, were then thickly sown in each pot.

As germination proceeded, it was quite evident that the chemical had injured a fairly large number of the seedlings, especially those near the chemical, since all the treated pots had a much lower stand toward the center and the seedlings were considerably retarded. When some of these were dug up it was noticed that roots and lower parts of stems were discolored, shriveled, and, in a number of instances, completely killed. An enlargement or swelling was often noted in the parts adjoining the discolored, dead areas. Microscopic examination of recently injured parts showed no fungus or bacterium which was common to all, and as the untreated pots all possessed seedlings with no comparable symptoms, there can be little doubt that the chemical was responsible for the damage. However, quite a few

seedlings remained standing in the treated pots, and full opportunity was afforded to note the effects of the chemical on the nematode. The roots of untreated plants were severely infested, and the roots of the treated plants, although not having as many root-knots, also were infested. As the plants grew larger, root-knots on treated plants became more and more common, although they apparently were not quite as abundant as in the untreated. Irrespective of this, however, every one of the treated plants—and over 100 of these were examined—showed some root-knots. Microscopic examination of the swellings all showed one or more nematodes in the affected parts.

As there is a possibility of lack of gas diffusion in a moist soil, the 6 pots were permitted to dry out in the greenhouse for about two months, and the soil reworked and then again seeded to tomatoes. This drying killed most if not all the nematodes in the untreated pots, and the few swellings which were definitely identified as nematode injury all appeared in the treated pots. The characteristic odor of paradichlorobenzene which was noticed at the second seeding, although not nearly as strong as when first applied, indicated that the generated gas had sufficient opportunity of acting on the nematodes. The pots were carefully handled throughout, and efforts were made to prevent reinfestation. In view of these results, one may conclude that paradichlorobenzene is not an effective remedy against the nematode, *Heterodera radicicola*. The writer is greatly indebted to the Hooker Electrochemical Company for supplying the chemical used in the trials.

While negative results of this sort are of little value, they are offered with the hope of eliminating unsuccessful efforts of other workers.

UNIVERSITY OF ARKANSAS,
FAYETTEVILLE, ARK.

BOOK REVIEW

Plant Disease Fungi. By F. L. Stevens, Ph.D., Professor of Plant Pathology, University of Illinois. 469 pp. Illus. The Macmillan Company, New York, 1925.

This book follows the "Diseases of Economic Plants" (1910 and 1922) and "The Fungi Which Cause Plant Disease" (1913) by the same author. As stated in the preface, its aim "is to present the more important facts concerning the morphology and taxonomy of the fungous parasites that affect plants of importance in the continental United States with some discussion also of the more significant facts of morbid histology." To accomplish such an end a book must have both substance and form—must contain an adequate body of well chosen and accurate information and must present this in a telling and easily accessible manner. These requirements are fulfilled by this volume with an effectiveness that should render it as successful as its two predecessors. The form of the book is good. It is well turned out, clearly printed on a good quality of paper, contains an abundance of helpful illustrations, and all in all presents an attractive appearance. The arrangement of the subject matter is logical and easily followed. The fungi considered are treated in separate chapters by groups, and of these groups the main representatives are characterized. Their effects and life histories are touched upon briefly.

Of the 469 pages, the space and emphasis allotted to each of the main groups of fungi are justly proportionate to their importance. After a brief introduction, the Myxomycetes as Division 1 are dealt with in six pages; the Schizomycetes as Division 2 receive 41 pages; while the consideration of the Eumycetes as Division 3 occupies the bulk of the book. Under the Eumycetes, a general discussion of 6 pages leads to a detailed consideration of the Phycomycetes, 31 pages; the Ascomycetes, 123; the Basidiomycetes, 121; and the Fungi Imperfecti, 110 pages. A helpful index with a purely alphabetical arrangement that mingles authors, subjects, diseases, hosts, and parasites completes the total.

As the subject matter is to some extent a reconsideration of that already included in the two previous books, a greater freedom from typographical errors justifiably might be expected. Apparently a careful scrutiny of the book would yield a considerable list of such errors which, however, do not seem to require enumeration here; as, even though they have escaped thus far, one assumes that they will be corrected. Moreover, such an enumeration of typographical errors seems all too often to display the zeal of the reviewer rather than to offer belated aid in the onerous task of revision and correction. Meanwhile, those to whom these errors are self evident will not find the considerable value of the book reduced thereby; while for those by whom they are unnoted, they do not, pragmatically, exist.

Here and there throughout the subject matter occur statements that are somewhat misleading. For example, the summary dismissal of *Physoderma zeae-maydis* on page 61 as "discovered in India by Shaw in 1910 and in Illinois by Barrett in 1911" might be prevented from giving an inadequate impression of the history and occurrence of this species by the addition of a brief reference to the thorough investigation of its distribution in the southern part of the corn belt of the United States by the Plant Disease Survey. Also, in the discussion of the genus *Bremia* on page 79, the statement that

"There is only one species" hardly does justice to *B. graminicola*, established in 1913 by Naoumoff, and *B. elliptica*, *B. microspora*, *B. ovata*, *B. saussureae*, and *B. sonchi*, adequately described in 1914 by Sawada. Nor does the discussion of *Peronospora parasitica* on page 80 give due consideration to the fundamental work of Gaumann in justifiably separating this aggregate into several well defined species in 1915. Moreover, it is perhaps with a certain inconsistency that the Actinomycetales are placed among the Bacteria, when the description of the genus on page 48 emphasizes "a much branched mycelium which may break up into segments that function as conidia"; and the discussion of *Actinomyces scabies*, describes "Spores more or less cylindrical, 0.8–0.9 x 1.3–1.5 μ, from dextrorse, spiral hyphae of 3–14 turns," following Dreschler, whose intensive investigation of the genus has demonstrated convincingly that the Actinomycetales should be classed among the Hyphomycetes rather than among the Bacteria. Though not misleading, sentences such as "none are known among the pathogenes" (page 11), and "There is one or more carpogonia" (page 89), may be somewhat distressing; while the statement (page 332) that "Pycnidia with very small spores are sometimes called spermagonia, especially if the spores do not germinate, a custom to be deprecated" as it now stands leaves one wondering if the custom, at least in pathogenic fungi, should not rather be commended or even encouraged—perhaps with bordeaux mixture.

The numerous figures aid materially in the presentation of the subject matter; as they are for the most part well chosen, and well reproduced, to illustrate the descriptions that they accompany. In some cases, however, it is a question whether the figures used are as effective as others that might have been selected. Figure 37, showing the effect of potato scab on the phellogen, for example, might be replaced advantageously by drawings of the causal organism itself. Figure 69, though historic as Millardet's own, would be more instructive perhaps if taken from the beautiful plates of Istvanffi and Palinkas. Also, certain illustrations have lost much in being reproduced, as for example, figure 47 of *Physoderma zeae-maydis*, figure 56 of *Phytophora phaseoli*, 154 of *Herpotrichia nigra*, 336 of *Myxosporium corticolum* and others. The title of figure 74, reading "A sporangium with a columella (Mucor)," is rather misleading, as the most obvious part of the figure shows "mycelium (3 days old) of *Phycomyces nitens* grown in a drop of gelatine with a decoction of plums" as stated in the legend under the original figure in Sachs.

In conclusion, the outstanding fact that the book is a very valuable tool for the mycologist and plant pathologist, again should be emphasized. Therefore, having done my duty as a critic in noting certain scratches in the finish of this tool, I shall now proceed with the complacency of all critics, to make good use of it in my own work and that of my classes.—W. H. WESTON, JR.

ABSTRACTS OF PAPERS READ AT THE MEETING OF THE SOUTHERN SECTION OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY WITH THE TWENTY-SEVENTH ANNUAL CONVENTION OF THE SOUTHERN AGRICULTURAL WORKERS, AT ATLANTA, GEORGIA, FEBRUARY 3–5, 1926

Results of five years' selection for freedom from internal cob-discoloration in corn.—R. A. JEHLE, F. W. OLDENBERG, and C. E. TEMPLE.

A series of tests was conducted for a period of five years to determine the relation of the pink, gray, brown and other discolorations of the vascular and surrounding tissues of the interior of the cob to yield and to the root, ear, and stalk rot diseases. In each test the best seed ears were selected and the butts and tips cut off so that the interior of the cob could be examined. The corn was divided into three or more lots, according to the amount and intensity of internal cob-discoloration. At least two lots, one showing little or no internal cob-discoloration and one showing marked internal cob-discoloration, were planted in each test. The following results were obtained.

1. In 116 tests with field corn the average yield from cobs with little or no internal cob-discoloration was 60.11 bu. shelled corn per acre and the yield from cobs with marked internal cob-discoloration was 51.75 bu. shelled corn per acre. Thus the yield from cobs with little or no internal cob-discoloration was greater than the yield from cobs with marked internal cob-discoloration by 8.54 bu. or 16.56 per cent.

2. This increase on poorer corn land was 9.15 bu. per acre or 19.26 per cent, and on the best corn land it was only 4.75 bu. or 6.1 per cent. Thus the difference in yield was greater on the poorer corn land.

3. The difference in yield also was found to vary with the intensity of internal cob-discoloration.

4. Internal cob-discoloration can be decreased by selection. It has been almost entirely eliminated in four to five years by planting only seed of ears free from internal cob-discoloration.

5. Corn grown from ears with the least internal cob-discoloration has a more uniform stand and a smaller number of fallen and broken stalks, and less prematurely killed plants than corn grown from ears with the greatest amount of internal cob-discoloration.

Brown spot disease of soybean.—F. A. WOLF and S. G. LEHMAN.

Brown spot is primarily a foliage disease but occurs also on stems and pods. It first appears as irregular dark brown patches upon the cotyledons. Infections next appear on both surfaces of the unifoliate leaves as angular, reddish brown lesions varying in size from 1 to 5 mm. A pale green or chlorotic zone surrounds the diseased areas. The disease spreads to the trifoliate leaves where lesions become very numerous and coalesce to form large, light-brown, irregular areas in which the pigmentation gradually deepens to a dark brown or blackish brown color. As the disease progresses the lesions become so numerous as practically to cover the leaf area completely. In seasons favorable for

the disease, considerable defoliation of affected plants occurs. Defoliation begins with the lowermost leaves, which are first to become infected, and progresses upward with the advance of the disease on the plant.

On the stems the disease appears as indefinitely margined, brown discolorations varying in size from mere specks to areas several centimeters in length. Similar discolored areas occur on petioles and pods.

Globose pycnidia possessing thin, membranaceous walls and opening by a large pore are embedded in the tissues bearing mature lesions. The pycnidia are filled with hyaline, filiform, curved, indistinctly septate conidia. Inoculation experiments have demonstrated the pathogenicity of the causal organism. This fungus is identical with *Septoria glycines* described by Hemmi as the cause of a wide-spread and severe epiphytotic of brown spot disease in Japan in 1914. No ascogenous stage has been found. The fungus overwinters in the conidial stage on diseased leaves and stems and very probably survives in seed from diseased plants.

Soybean anthracnose.—S. G. LEHMAN and F. A. WOLF.

Soybean anthracnose was first observed at Raleigh, North Carolina, in 1920, and has reappeared repeatedly since then. The disease occurs on stems and pods but has never been observed on leaves, although plants in all stages of development are subject to attack. The disease reaches its most destructive stage at the time the pods are maturing. Diseased plants die prematurely, and affected portions become thickly covered with black acervuli which bear numerous setae. Pure cultures of the fungus have been isolated from cotyledonary tissues of seed from diseased pods. Both conidial and ascogenous stages of the causal fungus have been studied.

The soybean fungus was at first thought to be identical with the apple bitter rot fungus, *Glomerella cingulata*, but cultural and morphological comparisons have led to the conclusion that the two are distinct. Asci, ascospores, and conidia of the former are larger than those of the latter. The two fungi differ in appearance when grown on agar media and produce different types of rot on apple fruits. Conidia and ascospores of the soybean organism readily cause infection when sprayed on soybean plants; but, under the same conditions, spores of the apple bitter rot fungus fail to infect soybeans, nor does infection occur when bits of mycelium of the bitter rot fungus are inserted into soybean stem tissues. The fungus overwinters in diseased seed and on diseased stems and pods.

It is believed that the soybean anthracnose fungus studied by the writers is identical with *Colletotrichum glycines* Hori, which causes an anthracnose of soybean in the Orient. Since the perithecial stage is described by the writers for the first time, the soybean anthracnose fungus is given the new name, *Glomerella glycines* (Hori).

Pythium root rot of soybean.—S. G. LEHMAN and F. A. WOLF.

In July, 1923, soybean plants in the breeding grounds of the North Carolina Agricultural Experiment Station became affected with a root rot disease which obviously was different from other root rot diseases then known on this host. The presence of the disease was first made evident by the appearance of groups of withered and dying plants scattered throughout the field. On closer examination it was found that these plants were being attacked by an organism which was causing a decay of the roots and lower stem portions. By appropriate methods a fungus was isolated which is referred to as *Pythium de baryanum*. The fungus apparently enters the plants at or near the soil level, whence it grows downward into the roots and upward into the stem to a height of

several inches. Newly invaded stem tissues are at first watery and translucent, but as decay progresses the lesions become brown and the cortical tissues may become so completely disintegrated as to fall away. When diseased plants are pulled from the soil, the disintegrated cortical tissues often remain in the soil, leaving the central woody cylinder exposed.

The causal fungus is described and its taxonomic position indicated. The pathogenicity of the causal fungus was demonstrated by infection experiments.

Work of the Office of Cotton, Truck and Forage Crop Disease Investigations of the Bureau of Plant Industry, United States Department of Agriculture, in relation to Southern agriculture.—H. A. EDSON.

The field assigned by the Bureau of Plant Industry, United States Department of Agriculture, to the unit officially designated "The Office of Cotton, Truck and Forage Crop Disease Investigations" is the study of the cause and control of diseases of cotton, potatoes, sweet potatoes, truck crops, forage crops and herbaceous ornamental plants as well as drug and related plants. The active projects of the office cover only a portion of this field since some of the lines indicated have never been specifically financed in the budget and the funds made available for several others are so limited that only incidental work on them is possible. For this reason projects on the diseases of cotton, ornamentals, drug plants and many of the minor vegetable crops are inactive. In the prosecution of projects for which funds are available, it is the policy to select problems which are national, or at least broadly regional, in scope but which cannot be solved readily without crossing state lines. Cooperation with state stations in the investigation of the local phases of all problems is courted as a matter of policy and arranged for whenever feasible. Among the active projects of special interest to Southern agriculture may be mentioned the following: virus diseases of potatoes; sweet potato diseases; black heart of celery; mosaic disease of lettuce and tomatoes; lettuce breeding for resistance to brown patch and downy mildew; nailhead rust of tomatoes; tomato breeding for resistance to Fusarium wilt, nailhead rust, and mosaic; cabbage breeding for resistance to yellows; bean breeding for resistance to bacterial blight and mosaic; transit diseases of snap beans; watermelon diseases; alfalfa diseases; clover diseases.

Further experiments in the control of watermelon anthracnose with dusts and sprays.—O. C. BOYD.

The project begun at the Thomasville station in 1924 for the control of watermelon anthracnose was continued in 1925. Again Bordeaux mixture, a home-mixed copper-lime dust, and a commercial copper-lime dust were used on the Watson variety. The spray formula used in 1925 was 4–8–50, the "8" representing hydrated lime, with Kayso added in the last three applications. Both dusts contained 20 per cent monohydrated copper sulphate, and were applied to the vines with a hand duster equipped with a long outlet pipe. All dust applications were made in the late afternoon after the wind had subsided—not in the early morning on damp vines as in 1924. The spray applications were made with the same machine that was used the previous year, *i.e.*, the Hardie "Magic," an engine-power truck sprayer with lead-hoses, bamboo rods, and nozzles. Six applications of each fungicide were made with intervals of from seven to ten days.

The experimental field comprised 3.6 acres, with three plats of each treatment and three of the controls. Each dusted plat contained three rows, and the sprayed and control plats contained four rows each.

Anthracnose was the only disease of any consequence in the experiment. It was first observed on May 25 in a single hill of a dusted plat. The disease spread steadily in the untreated plats, first showing there about June 1. On June 20, the date of the fifth application of fungicides and four days prior to the first picking, practically every hill in the control plats showed leaf spots, with the majority of the older melons affected with pox. An occasional hill throughout the sprayed and dusted plats also showed both leaf and melon infection. By July 9, the date of the third picking and ten days after the last application, the check plats appeared brown and barren from defoliation and death of vines. The treated vines were still green and growing, but the disease was beginning to spread rapidly due to the exposure of considerable new growth that developed after the last application of fungicides.

There was little doubt but that the sprayed vines retained more fungicide per unit amount of copper applied than the dusted vines, and that the spray deposit was more resistant to washings by rain than the dusted vines. Nevertheless, the dusts, with applications ranging from 15 pounds per acre at the beginning to 80 pounds at the close of the season, furnished satisfactory control even when dusted on dry vines. The spray mixture furnished slightly better control on the leaves, with a doubtful difference on the melons. The number of mature melons per acre harvested under the different treatments, with the percentage of poxed melons in each case, was as follows: checks, 416 with 67.5 per cent; spray, 411 with 20 per cent; home-made dust, 431 with 22.9 per cent; commercial dust, 419 with 25.7 per cent poxed. The market value per acre, less pox, was as follows: $25.57, $77.77, $76.13, and $71.20 for the treatments in the same order as in the preceding sentence.

The amount of each of the dusts used per acre in the six applications was 325 pounds, containing 22.75 pounds of copper, compared with 625 gallons of Bordeaux mixture with 19 pounds of copper. The cost of the different materials was as follows: 100 gallons of spray, about $1.25; 100 pounds of the home-mixed dust, $4.80; 100 pounds of the commercial dust, $10.00. The total cost per acre was: $10.40 for the spray, $17.75 for the home-made dust, and $34.50 for the commercial dust. (The cost of the spray treatment might well be reduced $2.20, the cost of the 11 pounds of Kayso in the last three applications, making the cost $8.20 instead of $10.40.) Hence, the net returns per acre were: $25.57 for the untreated plats, $67.37 for the spray, $58.38 for the home-made dust, and $36.70 for the purchased dust.

Although the dusts this season furnished practically as good control as the spray mixture, with only slight injury to the vines, it should be remembered that anthracnose was not as prevalent as usual and that only hand machines were used for dusting. Before dusting can be given a definite place in anthracnose control, reservations will be made for further experimentation which will involve the use of mule-drawn dusters. It seems that the grower could afford to insure his crop for only about $8.00 per acre by spraying, or perhaps for about $18.00 by dusting with home-mixed dusts. The advisability of dusting with materials costing 10 cents per pound or more might depend on the severity of the disease in question and on the price of melons.—Georgia State Board of Entomology Experiment Station, Thomasville, Ga.

The pecan scab fungus.—J. B. DEMAREE.

The organism which causes the disease of the pecan commonly known as scab has for many years been referred to in literature under the name of *Fusicladium effusum* Winter. The type collection of the fungus was collected by Dr. F. S. Earle on white hickory near Cobden, Illinois, in 1882.

Bonorden described the genus *Fusicladium* as producing its conidia singly or in pairs on short unbranched hyphae. Until recently it was supposed that the pecan scab fungus also produced its conidia in a similar manner. It is now known that this organism produces its conidia in long chains acropetally on either simple or branched conidiophores; characters which are not considered typical of the genus *Fusicladium*. The appearance of the fungus on living pecan tissues and also its reaction on artificial culture media indicates that it has several characters in common with the form-genus *Cladosporium*. Its morphological resemblances to *C. carpophilum* Thum. are very striking and suggest that they may be congenerically related. The complete manuscript gives more comprehensive reasons for transferring the fungus to the genus *Cladosporium*.

The future of the chestnut as an orchard, ornamental and forest tree in the Southern Appalachians.—G. F. GRAVATT.

As the chestnut blight spreads over the Southern Appalachians, the few orchards of that region will be exposed to infection from diseased native growth. With some strains of the hairy Chinese chestnut (*Castanea mollissima*) and the Japanese chestnut (*Castanea japonica*) orchardists can control the blight at a reasonable cost. The cutting out of all infected bark tissue, together with ½ to 1 inch of healthy bark and ½ inch of sapwood under the canker, followed by painting with a mixture of creosote and coal tar, has proved very effective in eradicating the disease. Less drastic treatment in experienced hands is satisfactory.

Successful inoculations on varieties and species of chinquapins from different parts of the Gulf states and Arkansas indicate that the blight will eventually spread over the chinquapin area of the South.

The ornamental American chestnuts of the Southern Appalachians are doomed. Owners who are dependent upon these trees for shade should take immediate steps to plant resistant chestnuts or other kinds of shade trees to replace the native chestnuts when they die. Many strains of the Japanese and hairy Chinese chestnuts are sufficiently resistant to the blight to be grown with hardly any treatment, while others are rather susceptible and require considerable treatment. The beauty of these chestnuts and their production of edible nuts make them desirable trees for many situations.

The chestnut forest growth of the Southern Appalachians is also doomed. The blight is spreading more rapidly in the South than in the North, and already about one-fifth of the chestnut growth has 80 per cent or more of the trees infected.

Owners should make plans to utilize their chestnut poles before they are killed by blight because killed poles will usually not be accepted by purchasers. Severe losses have been suffered by many owners of standing poles, who failed to cut them before they were killed.

The forecast map on future spread, which predicts the death of most of the commercial chestnut of the Southern Appalachians before 1935, forces consideration of the problem of growing tanning materials to replace the chestnut. Over one-half of our present domestic production of tannin is secured from chestnut, and we are already importing one-half of the total tannin supplies consumed by our five hundred million dollar tanning and leather industry. From the viewpoint of the American farmer, the manufacture of chestnut tannin extract and leather is an ideal industry. In addition to providing the workers as a market for his food products, this industry consumes vast quantities of tanning materials from the farmers' wood land and uses his hides.

The investigations of the U. S. Office of Forest Pathology which affect this industry have been directed during the past two seasons toward determining, first, the present

distribution and rate of spread of the blight, and next, the rate of deterioration of killed trees.

The work of locating and breeding resistant chestnuts to replace the American chestnut as a source of tannin is being continued on a small scale.

Report on the experiment of 1925 for pecan scab control at Baconton, Ga.—O. C. BOYD.

The pecan station near Albany, Ga., which was established in the spring of 1925, undertook in that year among other projects that of pecan scab control. By reason of the more suitable orchard conditions, with respect to the prevalence of the disease, susceptible varieties, and other factors, the experiment of the first year was conducted at Baconton, Ga. The object of the experiment was to test the effectiveness of some copper dusts in comparison with Bordeaux mixture. The primary motive was the realization by growers of the difficulties in, and the limitations to, the spraying of pecans, and a mere hope that there might be a dusting method that might supplement to advantage, or possibly even replace spraying. It is well known now that dusting is proving both effective and practicable in the prevention of diseases of other fruits, and if such a method should prove effective and economical in preventing scab in the less susceptible varieties of pecans, such as Alley, Schley, Pabst, and others, it would mean thousands of dollars to growers and to the pecan industry.

The experiment was conducted on 16-year old Delmas, Schley, and Alley trees, the majority being Delmas. The Delmas variety began to scab in 1919, and the other varieties in 1922 or 1923. The 1924 crop of Delmas was almost a total loss from scab. The orchard equipment consisted of a Dosch fruit duster and sprayers of the Hardy and Friend makes. The fungicides compared were: Bordeaux mixture 4–8–50, the "8" being hydrated lime; a home-made dust of monohydrated copper sulphate, hydrated lime, and Kayso; a commercial copper-lime dust of the same formula, but without the Kayso; and a Bordeaux dust carrying an electrical charge prepared by the Kil-Tone Company. Five applications of spray were made, and nine of the dusts, the first four of the latter made in the evening and the remainder in the early morning.

Although the protection program was not begun until three or four weeks after scab appeared on the young leaves, yet the dusts held the disease in satisfactory control throughout the season on Alley and Schley, but proved less effective on the Delmas variety. On all varieties the spray mixture produced a higher degree of control than any of the dusts, but tended to accumulate heavily on the leaves during the unusually dry season. Even the spray failed to furnish complete control on any of the varieties owing to the late start in the spray program and to the fact that the first two applications were made with a defective sprayer. The spray mixture surpassed all three dusts in adhesiveness to nuts and foliage. The home-made dust outranked the two commercial dusts, in both adhesiveness and degree of scab prevention. The Kil-Tone dust with the electrical charge exhibited no greater tendency to be retained by the leaves and nuts during the application, and showed even less resistance to washings by rains than the copper-lime dusts. It showed the least amount of control of the three dusts.

All of the untreated Delmas trees lost 100 per cent of their nuts from scab, the sprayed trees 2.9 per cent, and those dusted with the home-mixed dust, the commercial copper-lime dust, and the Kil-Tone dust 21.2 per cent, 54.6 per cent, and 68.7 per cent respectively. The mature nuts from the sprayed Delmas tested 76 per cent marketable regarding the filling qualities, as compared with 91.4 per cent, 83.0 per cent, and 77.8 per cent for nuts from the trees dusted with the home-made dust, the commercial copper-lime dust, and the Kil-Tone dusts respectively. Also, the meats of the sprayed nuts were of poorer quality in respect to plumpness, oil content, color, flavor, etc. The per-

centage of the total number of Delmas nuts that graded marketable was 73.5 per cent for the spray, 71.7 per cent for the home-made dust, 37.5 per cent for the commercial copper-lime dust, and 24.2 per cent for the Kil-Tone dust. The Alley checks lost 9.7 per cent of the nuts from scab as drops, and the Schley checks 3.6 per cent. Only traces were lost from the sprayed or dusted trees of those varieties.

The accumulation of the spray deposit on the leaves under the drouth conditions caused some premature defoliation in all three varieties and undoubtedly accounted for the inferior quality of the sprayed nuts. No injury was noticed from the dust deposits.

Not figuring the price of machines with their depreciation, or the other equipment necessary in connection with spraying pecans, it cost about $6.75 to spray an acre of 18 trees once, $10.20 to dust with the home-made copper-lime dust, $16.35 to dust with the commercial copper-lime dust, and $10.15 to dust with the Kil-Tone dust. With the Delmas variety, the average number of pounds of marketable nuts per tree for the different treatments was as follows: spray 31.2, home-made dust 32, commercial copper-lime dust 12.5, and Kil-Tone dust 10.1. Assuming that the marketable nuts brought the same price, say 40 cents, it would require the following number of pounds of pecans per tree to pay for the different treatments: spray 4.7, and 13, 20, and 13 for the dusts in the same order as listed above.

While these represent results from only one season, and moreover a season of unusual drouth, yet they appear to be quite suggestive in indicating, under the conditions, the comparative fungicidal value of the four materials used, as well as their effect on the function of the tree. Further experiments are being planned to test the effectiveness and practicability of dusting for pecan scab.—Georgia State Board of Entomology Pecan Station, Albany, Ga.

Recent progress in the control of cereal smuts.—W. H. TISDALE.

Considerable progress has been made in recent years in the control of cereal smuts by the Office of Cereal Investigations, U. S. Department of Agriculture, in cooperation with the state agricultural experiment stations of California, Illinois, Kansas, Minnesota, Missouri, New York, Oregon, Wisconsin, and Washington. Seed treatment and varietal resistance are the principal lines of attack. Studies are being made of some of the fundamental factors influencing progress along these lines.

Among the most important developments along the lines of seed treatment was the introduction in 1920 of the copper-carbonate dust treatment for the control of bunt of wheat. This treatment is now being recommended for the control of covered kernel smut of sorghum.

More recently certain organic mercury compounds, including chlorphenol, cresol, and ortho-nitro-phenol derivatives of mercury, have proved effective in the control of some of the cereal smuts. They are especially desirable for the control of barley smuts. They do not cause seed injury, as is true with the standard formaldehyde and copper sulphate treatments.

A single bath hot-water treatment has been devised for the control of loose smut in wheat which is effective and less injurious to the seed than is the modified hot-water treatment. The seed is held, without presoak, in water at 49° C. for 1 hour and 35 minutes, or at 48° C. for 1 hour and 50 minutes.

In the resistance studies, many varieties and selections or strains of the various cereal crops have been subjected to attack by their respective smuts under conditions favorable for heavy infection. The most resistant material from these experiments is used as breeding stock for combining resistance with quality and high yielding capacity.

In some instances resistance has been found associated with these desirable characters. A number of commercially desirable resistant varieties have been discovered or developed through these studies. Among these are Hussar, Martin, Ridit and Sherman wheats which are highly resistant to bunt; Shepherd, Mammoth Red, Trumbull and other varieties of wheat which are resistant to flag smut; Markton, a variety of oat which resists both oat smuts; and Federita, a kernel-smut-resistant sorghum. There are many other varieties and selections or strains of the cereals which are either smut free or practically smut free. Many of them are being used in our breeding program. A variety may be resistant to a certain physiologic form of smut and susceptible to another form of the same species. This complicates our breeding program.

REPORT OF THE SEVENTEENTH ANNUAL MEETING OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

The seventeenth annual meeting of the Society was held at Kansas City December 28–31, 1925, in conjunction with the American Association for the Advancement of Science and affiliated societies. The Hotel Baltimore was the headquarters, and the fact that the meetings were held in the rooms and parlors of this hotel added greatly to the convenience and success of the meeting. It is estimated that about 140 members were in attendance.

Seventy papers were presented at the regular sessions, and ten more were given by members at the joint ssion with Section O on the subject of disease resistance in field crops, thus making a total of 80 papers. Two conferences, one on teaching and the other on extension work in plant pathology, and the usual joint session with Section G, were held. Abstracts of papers were distributed at the meetings and later published in Phytopathology (Phytopath. **16**: 63–88. 1926). A popular account of the meeting, including a summary of facts brought out in some of the more important papers, has appeared in connection with the report of the Permanent Secretary of the American Association for the Advancement of Science (Science **63**: 132–133. 1926).

At the joint session with Section G on December 29 four papers were presented, as follows: *Botanical Problems of American Tropical Agriculture*, by W. A. Orton; *The Present Crisis in Plant Physiological Science*, by Burton E. Livingston; *The Nature and Cause of Persistency of Secondary Sexual States with Special Reference to Typha*, by John H. Schaffner; and *Increasing the Life Activities of Plants by Chemical Treatments*, by F. E. Denny.

The subject of teaching plant pathology was discussed at the conference on December 30 by N. J. Giddings, C. W. Edgerton, R. E. Vaughan, and others; and papers by H. H. Haymaker and L. R. Hesler were read.

The Phytopathologists' dinner, which was held at the Hotel Baltimore, December 30, was attended by 174 persons. The program consisted of remarks by the president, C. W. Edgerton; information concerning the coming International Plant Congress, by H. H. Whetzel; the reading of a telegram to Dr. G. R. Lyman, who was unable to attend on account of illness; singing by a quartet and by the assembly, led by Donald Porter; and a two-act play by members of the Society from Ames, Iowa, and Manhattan, Kansas.

Officers and Representatives

The following officers were chosen, the first four being elected by the Society and the others selected by the Council and approved by the Society.

President, I. E. Melhus, Agricultural Experiment Station, Ames, Iowa.

Vice-president, H. B. Humphrey, U. S. Department of Agriculture, Washington, D. C.

Secretary-Treasurer (three years), R. J. Haskell, U. S. Department of Agriculture, Washington, D. C.

Councilor (two years), J. B. S. Norton, Agricultural Experiment Station, College Park, Md.

Associate Editors of Phytopathology (three years), M. W. Gardner, Agricultural Experiment Station, Lafayette, Ind., to succeed W. D. Valleau; N. E. Stevens, U. S. Department of Agriculture, Washington, D. C., to succeed R. D. Rands; H. H. Whetzel, College of Agriculture, Ithaca, N. Y., to succeed W. A. McCubbin; G. W. Keitt, Agricultural Experiment Station, Madison, Wis., to succeed L. W. Durrell.

Business Manager (one year), R. J. Haskell, U. S. Department of Agriculture, Washington, D. C.

Advertising Manager (one year), J. F. Adams, Agricultural Experiment Station, Newark, Del.

Representatives on the Council of the American Association for the Advancement of Science (one year), G. P. Clinton, Agricultural Experiment Station, New Haven, Conn., and Donald Reddick, Agricultural Experiment Station, Ithaca, N. Y.

Member of Editorial Board, American Journal of Botany (three years), G. K. K. Link, University of Chicago, Chicago, Ill., to succeed G. R. Bisby.

Representative on Committee on American Type Culture Collection (one year, 1926, but thereafter for a three year period), C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

Members of Advisory Board (three years), S. M. Zeller, Agricultural Experiment Station, Corvallis, Oregon, to succeed C. W. Hungerford as Commissioner for the West; B. B. Higgins, Agricultural Experiment Station, Experiment, Ga., to succeed L. R. Hesler as Commissioner for the South; F. D. Fromme, Agricultural Experiment Station, Blacksburg, Va., to succeed L. R. Jones as Commissioner at large.

Members of Board of Governors of the Crop Protection Institute (three years), I. E. Melhus, Agricultural Experiment Station, Ames, Iowa, to succeed C. R. Orton; the other members of the Board are M. F. Barrus and N. J. Giddings.

The following temporary committees were appointed by the President to serve throughout the meetings: *Resolutions Committee*, F. D. Fromme and I. E. Melhus; *Auditing Committee*, S. M. Dietz and J. L. Weimer; *Elections Committee*, G. R. Bisby and R. S. Kirby; *Reporting Committee*, W. A. McCubbin and E. L. Nixon.

REPORT OF THE SECRETARY-TREASURER, 1925

During 1925, 46 members were suspended for non-payment of dues, 8 resigned, and 3 died, making a total loss of 57 and reducing the total membership of the Society on December 20, 1925, to 603. Of these 603 members, 109 are life sustaining members and 494 regular members. Sixty-five life memberships were paid up in full December 20, 1925. At the Kansas City meeting 69 candidates were elected, thus making the total membership 672. Of these candidates for membership, 12 came from New York, 7 each from Iowa and Minnesota, 5 from Japan, 4 each from Wisconsin and California, 3 from Canada, 2 each from the District of Columbia, Ohio, Florida, Illinois, Kentucky, and Washington, and the remainder from scattered states.

STATEMENT OF ACCOUNTS FOR 1925, AS OF DECEMBER 19, 1925

Receipts:			
Balance from 1924			$3,504.54
Annual dues: 1923		4.00	
1924		12.00	
1925		1,012.02	
1926		1,600.60	2,628.62
Sales received with annual dues			7.00
Excess dues			10.15
Interest: Checking account		59.02	
Time deposit		63.88	122.90
Time deposit transferred to checking account			500.00
Cash for Phytopathologists' dinner tickets			4.00
			$6,777.21

Expenditures:		
Amount transferred to Sinking Fund for investment	630.00	
Secretarial work	65.00	
Postage stamps	20.10	
Excess dues refunded	6.00	
Member subscriptions transferred to Phytopathology	3,912.00	
Expenses of Committee on International Botanical Congress.	16.25	
Printing (Preliminary announcements, program, nomination blanks, ballots, bills for dues, Advisory Board stationery)	105.70	
Checks returned by bank	18.00	
Expressage and postage on stationery	2.75	
Complimentary dinner tickets	9.00	
		$4,784.80
Balance		$1,992.41
Outstanding check		16.25
		$2,008.66
Amount of above receipts credited on 1926	1,600.60	
Amount due Phytopathology for European donations	60.98	
Amount due Phytopathology for sales with dues	7.00	
		1,668.58
Actual balance for 1925		$340.08

REPORT OF THE BUSINESS MANAGER OF PHYTOPATHOLOGY FOR 1925

PHYTOPATHOLOGY has come through the year with a balance of nearly two hundred dollars in excess of 1924, and in addition has used about thirteen hundred dollars more than last year for expansion. The accompanying statement of accounts shows a bank balance of $2,271.39 and an investment of surplus funds of $1,003.25, which together total $3,274.64.

The present financial status of the journal as compared with that of 1924 is shown graphically on the accompanying chart. Receipts from all sources, with the exception of subscriptions and members' subscriptions, have increased materially over last year. Attention is called especially to returns from advertising and sales of back numbers.

Subscriptions. The number of paid up subscriptions for 1925 on December 20 was 407, of which 246 were foreign and 161 domestic. This is an increase of 29 over 1924. The number of subscribers in good standing at the end of each year for the past five years is shown in table 1. Most of the increase during the past few years has been due to new foreign rather than domestic subscriptions. Russia, Germany and Japan lead in numbers of new subscriptions in 1924 and 1925.

The reduced rates to European subscribers, adopted by the Society at the Washington meeting, have been in force during the year. These prices, based on exchange rates, have resulted in a cost of approximately $140. This has been offset to some extent by the securing of European subscriptions that probably would not otherwise have been obtained. Out of 59 new subscriptions in 1925, 37 were from the European countries concerned, divided as follows:—Russia 14, Germany 9, England 3, Belgium 2,

TABLE 1.—*Subscriptions to Phytopathology*

Year	Number of subscriptions	Increase over previous year
1920	276	—
1921	287	11
1922	320	33
1923	340	20
1924	378	38
1925	407	29

and one each from Austria, Czechoslovakia, Finland, France, Ireland, Italy, Serbia, Spain, and Sweden.

Members' subscriptions. The amount of money received from members' subscriptions this year has been slightly less than last year in spite of an increase in membership. This is largely owing to the use of only $4.00 of each sustaining life membership installment instead of $5.00 as has been done in the past. Also, in 1924, a few life members paid dues in advance.

Advertising. The actual amount of money received from advertising, as shown by the accompanying chart and statement of accounts, was $1,176.32, an increase of $479.03 over last year.

The receipts from the particular advertisements that appeared in the 1925 volume will be about $1140 as compared with $781.50 in that of 1924, which, owing to the activities of the advertising manager, is an increase of $358.50.

Receipts from advertising during the last seven years have been as follows:

1919	$ 221.45
1920	193.83
1921	309.32
1922	519.06
1923	594.57
1924	781.50
1925	1,141.24

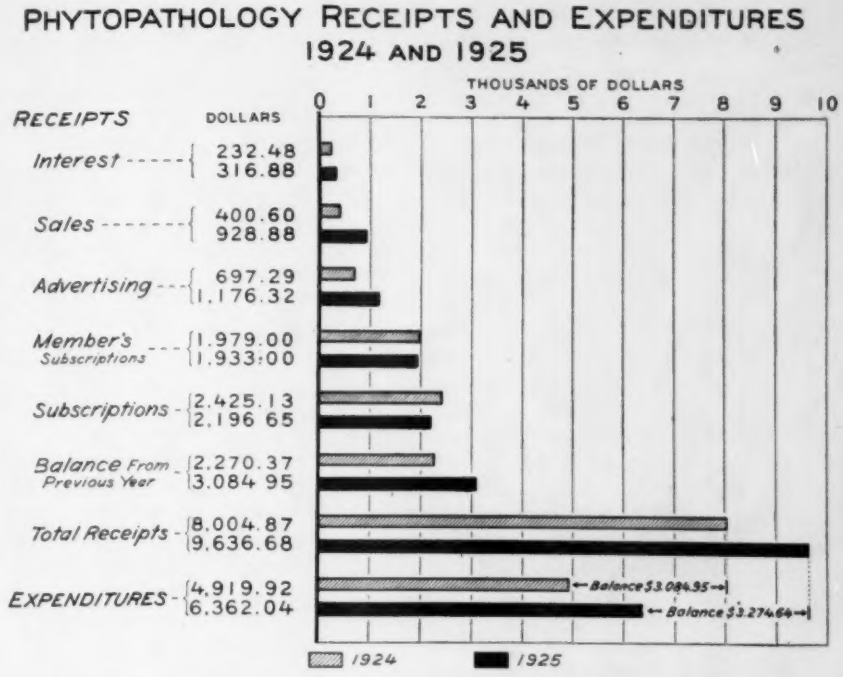
Sales. Sales of back numbers more than doubled those of 1924. An unusual number of large orders were received from institutions, especially in foreign countries, for complete sets of the journal. Many requests also came from persons desiring the last few volumes. In all, 80 separate sales of back numbers were made.

Sinking fund. The sinking fund, resulting from payments of life sustaining members, now amounts to $4,750.00. This is invested in seven mortgage notes ranging in denomination from $500.00 to $1000.00 and bearing 6, 6.5, and 7 per cent interest.

At the Washington meeting the Council authorized the secretary to put $6.00 out of every $10.00 contributed by life sustaining members into the sinking fund, instead of $5.00 as heretofore. This has resulted in an addition to the sinking fund and a diversion from PHYTOPATHOLOGY in 1925 of one dollar for every life sustaining member or $110.00. For 1926 the amount will be about $45.00, as 65 members have now completed their payments.

Expenditures. Owing to the increased size of Volume 15 of PHYTOPATHOLOGY, 732 pages in the first eleven numbers as compared with 536 pages in the corresponding

numbers of last year, the cost of manufacture was considerably greater than last year. It cost $5,102.62 to prepare numbers 1 to 11 of Volume 15 and $3,801.20 for the same numbers of Volume 14, a difference of $1,301.42. The increased cost is entirely due to the greater number of pages and cuts, as printers rates and costs of paper have remained the same. Volume 15 is by far the largest ever issued.



The increased postage rates on second class matter which went into effect January 1 of last year have resulted in an increased cost over last year of about $36.00 for mailing back numbers from Washington and College Park, Maryland, where back volumes are stored. The increased rates did not affect the publisher at Lancaster, but owing to the greater weight of this year's volume, the cost of mailing the first eleven numbers was $223.25, or $64.14 in excess of 1924.

Another item of expense which appears for the first time this year is that of insurance on back volumes of Phytopathology that are stored at College Park, Maryland. Although located in a building that is supposed to be fireproof, they are stored in a room with bulletins and other inflammable matter, and so it seemed advisable to insure them against fire. Accordingly a policy, costing $65.00 and extending over a three year period, was purchased.

STATEMENT OF ACCOUNTS FOR 1926, AS OF DECEMBER 19, 1925

Receipts:

Balance from 1924	$1,105.95
Subscriptions ($706.99 for 1926)	2,196.65
Sales	928.88

Advertising, 1924	174.01	
1925	962.98	
1926	39.33	1,176.32
Interest on invested sinking fund		316.88
Balance due sinking fund		630.00
Principal of Kaulbeck mortgage note paid		1,000.00
Member subscriptions from Society for 1924		1,979.00
Member subscriptions from Society for 1925		1,933.00
		$11,266.68

Expenditures:

Manufacturing Phytopathology:		
Vol. XIV. No. 12	321.91	
Vol. XIV, Index	148.65	
	470.56	
Vol. XV, No. 1	362.58	
Vol. XV, No. 2	383.79	
Vol. XV, No. 3	369.76	
Vol. XV, No. 4	332.78	
Vol. XV, No. 5	457.28	
Vol. XV, No. 6	228.99	
Vol. XV, No. 7	485.61	
Vol. XV, No. 8	391.49	
Vol. XV, No. 9	380.64	
Vol. XV, No. 10	429.22	
Vol. XV, No. 11	534.85	
Engravings for Vol. XV	745.63	
	5,102.62	
		$5,573.18
Printing Phytopathological Abstracts		14.51
Expenses of Editor in Chief (including letterheads, postage, etc)		40.43
Expenses of Advertising Manager (including envelopes, advertising sheets, printing stationery)		80.46
Second class postage (mailing back vols. from College Park)		33.98
Secretarial work		260.00
Postage stamps		23.00
Sinking fund invested with accrued interest		1,760.79
Printing letterheads, billheads for Business Mgr.		34.71
Purchase of stamped envelopes		56.85
Insurance on stock of back volumes		65.20
Miscellaneous expenses, account books, telegrams, graphs, paper and labor in tying back volumes		32.43
Duplicate subscriptions refunded		16.00
Excess advertising refunded		.50
Investment of surplus funds with accrued interest		1,003.25
		$8,995.29

	$8,995.29
	$2,271.39
Outstanding check	15.00
Balance	$2,286.39

Assets:

Cash in bank (balance as shown in statement of accounts)	$2,286.39
Sinking fund (invested)	4,750.00
First mortgage (surplus)	1,000.00
Amount due from sales made	59.00
Amount due from advertising	160.80
Amount due from subscriptions	317.75
Member subscriptions to date	1,081.00
Cash and checks on hand to be deposited	88.96
Sales received with member's dues (now in Society account)	7.00
Amount due Phytopathology for European subscriptions	60.98
Total assets	$9,811.88

Liabilities:

None.

REPORT OF THE EDITOR-IN-CHIEF OF PHYTOPATHOLOGY

Volume 15 of Phytopathology contains 810 pages, comprising 86 articles, 23 notes, 7 reports, 3 book reviews, 40 plates, and 140 text figures. About 150 manuscripts, including notes, were submitted. Of these, 35 were returned to the authors for revision, and 6 were rejected or withdrawn under pressure. It is the largest volume ever issued. While it is gratifying to have published so much material, the Editorial Board assumes no particular credit, except that it took advantage of the congestion of several other journals and invited pathologists to submit their papers to Phytopathology, with the promise of relatively prompt publication. The fact that there were sufficient funds to publish so much material is due to the energy, efficiency, and effective business sagacity of the Business Manager and the Advertising Manager. The contribution of $350 by the Graduate School of the University of Minnesota for editorial assistance also enabled the editors to handle more manuscripts than they otherwise could have done. The editor wishes also to acknowledge the accommodating helpfulness of A. E. Urban, Manager of the Science Press Printing Company, in the onerous task of issuing the journal.

Unfortunately, not all of the numbers were issued on time, owing partly to the readjustments necessitated by the change in personnel of the Editorial Board, partly to the delays caused by sending poorly prepared manuscripts back and forth for revision, and partly to perfectly natural causes.

Most papers were published in order of receipt, although the exigencies of "make up" often makes it difficult to fit papers into the number for which they are scheduled. And it should be perfectly clear that poorly written manuscripts which require extensive editing and revision can not be sent to the printer as promptly as those which are ready for publication when received. Much time is consumed in editing poorly-written manuscripts and sending them back and forth between author and editor, a process which often must be repeated several times. On the other hand, when few or no changes are necessary, manuscripts can be marked for the printer and sent merrily on their way without delay.

During the past year the Editorial Board has not discriminated against papers on account of length. It seemed far better to publish good papers, even though long, than to clutter up the journal with many short but mediocre contributions. Not that there is necessarily any merit in length; some people apparently try to make a paper long merely in order to have a few more published pages to their credit or to appear erudite. This is deplorable but true. The shorter the paper, provided the brevity is compatible with completeness and clearness, the better the impression it makes. However, short papers should not degenerate into mere news items, plant disease survey notes, or notices that a field of investigation is preempted.

A discussion regarding the quality of papers acceptable for Phytopathology raises a delicate question. There seems to be little unanimity of opinion as to what constitutes a valuable paper. The Editor took a ballot on the quality of papers appearing in several numbers of Phytopathology, and, if the results had been plotted, a corkscrew curve would have resulted. What seems superfluous and piffling to some may seem important and valuable to others: a paper may be fertile with information and ideas for some pathologists but completely barren for others.

Borderline papers constitute a real problem, often resulting in considerably increased nocturnal wakefulness on the part of members of the Editorial Board. To do justice to an author and at the same time maintain a high standard for the journal is sometimes a difficult equilibristic feat. When the Editor was in doubt regarding the acceptability of papers submitted, he asked the opinion of as many different individuals as possible.

No attempt is made to compete with the Atlantic Monthly in excellence of style. Style, after all, is a somewhat elusive thing, but it does not require a stylist to observe that some papers have no style at all. Readers have the right to expect that scientific results will be presented clearly, concisely, and consecutively. It should be possible for a reader to get the writer's meaning without doing literary detective work. Ambiguity, prolixity, redundancy, and deadening monotony of expression completely spoil many manuscripts. Certainly the first three have no place whatever in scientific papers. Even an amateur editor can detect such glaring faults; in fact they often overwhelm him with their obviousness. Some authors have intimated that insistence on correctness of expression and punctuation are carried to extremes of picayunishness. Some have insisted that the reader can unravel a sentence about half a page long, containing six or seven subjects, fifteen or twenty modifiers and a score of verbs, half of which are not in agreement with the subject. Maybe so. The reader probably could solve a cross-word puzzle too, but scientific journals are not designed to furnish that sort of mental test. Papers should be written clearly enough to enable a reader to get the meaning quickly and as painlessly as possible.

The readers have a right to expect that every paper shall contain an introduction to the subject, a clear-cut statement of the objects of the investigation, a complete but concise statement of the results, a discussion of the significance of the results, and a brief but comprehensive summary.

There should be some references to literature cited. There seems to be an increasing tendency, as pointed out by the previous Editor-in-Chief, for many pathologists to disregard previously published results. With the tremendously increased volume of literature, the formulation of a policy with respect to literature citations is difficult. But it does seem that reference should be made at least to some previous papers which have summarized the contributions made up to the time they were published.

The quality of papers submitted for publication in Phytopathology should be improved. This is true both of substance and form. A paper should contain a con-

tribution to knowledge or thought, and the material should be well presented. Unfortunately, scientific manuscripts usually are written by professional scientists but amateur writers. And they show it. In many of the papers the most elementary rules of English composition are violated; and others are full of obvious typographical errors which the authors should have corrected before the manuscripts were submitted. There is a deplorable tendency on the part of authors to exceed all speed limits in rushing their papers into print. This is a perfectly natural desire with which the Editor sympathizes, but it is not fair either to the paper or the author—to say nothing about the Editor or the readers. No one has a right to throw his results together in the most haphazard way and expect an editor to polish his paper for him. Some authors try to make their major revision on the galley proof, or even on the page proof. The time to write a scientific paper is before it is published and not afterwards.

Every author, no matter how experienced he may be, should submit his manuscript to some colleague before submitting it for publication. There would be fewer retractions and explanations if this were done. About 90 per cent of the authors should enlist the aid of a professor of English or an experiment station bulletin editor. If they did, their papers would be published more promptly and would be more favorably received by the long-suffering reading public.

It should be remembered, also, that the members of the Editorial Board of Phytopathology are not professional editors; consequently they also make mistakes. The guide posts on the road to a better Phytopathology say, better papers and fewer mistakes, all along the line.

REPORT OF THE ADVERTISING MANAGER

The total number of advertisements for the twelve issues during 1925 was 118, or an increase of 49 per cent over 1924. This total of advertisements was distributed as follows: 46 full page; 38 one-half page; 16 one-fourth page; and 10 one-eighth page, making a total of sixty-nine and one-fourth pages of advertising or seventeen and one-fourth pages over 1924, representing a 33 per cent increase.

It was necessary to carry on an extensive amount of correspondence in order to secure this small increase. In order to lighten the correspondence and broaden the interest of PHYTOPATHOLOGY as an advertising medium, a campaign with the slogan "Add an Ad in Phytopathology" was launched. Attractive stickers with this slogan were printed and distributed to departments for use by members on correspondence, requisitions, etc., to concerns which should be attracted to our publication for advertising. Through the cooperation of two members, this campaign resulted in securing advertisements from only two concerns, which was sufficient to pay the relatively small expense of the campaign. It has been very difficult to secure recognition from companies manufacturing spray, laboratory, and microscopic equipment. It is urgently requested that all members, if at any time in contact with various commercial representatives, take the opportunity of presenting the merits of PHYTOPATHOLOGY as a practical and efficient publication in which to advertise. A reasonable advertising increase for 1926 can only be anticipated by personal cooperation of members.

REPORT OF THE ADVISORY BOARD

The Advisory Board made the following report through its Chairman, M. F. Barrus.

The personnel of the Board of 1925 is as follows: F. C. Meier, Secretary, representing the U. S. Department of Agriculture; N. J. Giddings, representing the Northeast; L. R. Hesler, representing the South; M. W. Gardner, representing the Midwest; C. W. Hungerford, representing the West; J. E. Howitt, representing Canada;

and L. R. Jones and M. F. Barrus, Chairman, members-at-large. The Council has appointed the following to the Advisory Board for 1926: S. M. Zeller to succeed C. W. Hungerford, B. B. Higgins to succeed L. R. Hesler, and F. D. Fromme to succeed L. R. Jones. At a meeting of the Advisory Board, N. J. Giddings was elected chairman for 1926.

Summer Meetings. Two summer meetings of the Society were held in 1925, one at Corvallis, Oregon, June 22–24, in conjunction with the annual meeting of the Pacific Division, and a cereal conference in Iowa, Minnesota, and North Dakota, held July 8 to 14. Brief reports of these meetings have been published in PHYTOPATHOLOGY.

The Advisory Board has decided to hold the summer meeting for 1926 at Ithaca, August 21 and 22, in connection with the meeting of the International Congress of Plant Sciences.

Tropical Research Foundation. The following report has been received from W. A. Orton, Director and General Manager of the Foundation:

"The leading project, investigations of sugar cane production problems in Cuba for the Cuba Sugar Club, an association of 57 of the leading sugar mills in that country, has now been in progress for one year. A well equipped experiment station building has been erected at Central Baragua, Camagüey Province, near the center of the Island, and experimental fields laid out and planted. A branch station for varietal studies has been established at Herradura, Pinar del Rio, and field experiments on mosaic have been located at two other points, Jatibonico and Jobabo. A general survey has been made of the cane areas of Cuba, and a reconnaissance soil survey cooperative with the Bureau of Soils is nearly completed. This work is in charge of Mr. D. L. Van Dine, Field Director, with the following staff: James A. Faris and Marion N. Walker, Pathologists; C. F. Stahl, Entomologist; R. V. Allison, Chemist and Soil Biologist; S. Lomanitz, Chemist; F. S. Earle, Sugar Cane Technologist (half time); A. V. Svitzer and Luis Scaramuzza, Field Assistants.

"Our energies are concentrated in the main on four important problems; mosaic, root disease, cane borer, and cane varieties.

"The second project, forestry investigations in Cuba, was beguh on November 1, 1925. This involves a reconnaissance survey of eastern Cuba, which is supported by the United Fruit Company and the Cuba Company. The scientific staff includes the following: Dr. H. N. Whitford, Mr. Thomas H. Gill, Mr. William Crosby, and Mr. Donald Matthews, the first two for a temporary period.

"The Foundation is about to send an expedition to the west coast of Peru to advise the *Sociedad Agraria* relative to experiment station problems and organization for sugar cane and cotton."

National Research Council. The chairman of the Board attended a meeting of the Division of Biology and Agriculture held at Washington during April. The following projects reported at that time and later have some relation to plant pathology:

"In order to hold the representation on the Division to an effective working body, to keep expenses within reasonable limits, and to maintain representation of the national research societies," a plan has been proposed whereby the present membership may be reduced by means of group representation. By this plan, which was later approved by the executive committee of the Division, The American Phytopathological Society is grouped with The Society of American Bacteriologists. These two societies will select one representative on the Division. This plan is to be voted on at the next annual meeting of the Division.

The Committee on Phytopathology in the Tropics has concerned itself primarily with the promotion of a plan for a graduate school of tropical agriculture, with an

associated botanical garden and research biological station, to be located in southern Florida. Dr. W. A. Orton has recommended that, as it may be found desirable to broaden the scope of the proposed station, a new committee be formed to take the place of the old one, and this suggestion was approved by the Division. The new body is called the Committee on Subtropical Biological Institution. The personnel of this committee is W. A. Orton, Chairman, M. M. Metcalf, and R. A. Harper.

The Committee on Research Publications is a joint committee with the Union of American Biological Societies with Dr. C. E. McClung as chairman, appointed to ascertain the needs of the various research journals in biology.

The Joint Publication Committee is composed of four members appointed by the Union of American Biological Societies, four by the Division of Biology and Agriculture, one by the American Association for the Advancement of Science, one member-at-large, and a representative of the English biologists. Meetings have been held for discussion and action on phases of the Biological Abstracts Journal.

Official endorsement of the Biological Abstracts Journal has been made by the British Association for the Advancement of Science and the Australian Research Council, and unofficial assurance of cooperation by the Japanese Research Council. Dr. J. R. Schramm as editor-in-chief is engaged in getting the journal under way and abstracting will be begun with the 1926 literature, with publication of abstracts later in the year.

The Arthur Rust Project was reported as follows by Dr. C. R. Orton:

"Dr. J. C. Arthur and Dr. F. D. Kern during July and August visited the leading rust specialists of Europe, including Dietel, Sydow, Eriksson, Jorstad, and Butler. Expenses for Dr. Arthur were paid by himself and of Dr. Kern by special arrangement of Pennsylvania State College. The purpose of the trip was (1) to discuss various theoretical problems connected with taxonomy and morphology, (2) to discuss nomenclature especially as regards Dr. Arthur's terminology *vs* the old terminology. The results of this visit are (1) general agreement on the first point (2) division of agreement on the second point, a majority of the Europeans thinking the new terms unnecessary.

"The persons selected to write the rust book are Drs. Arthur, Kern, Fromme, Bisby, Mains, Jackson and Orton. The book has been completed except for a chapter on control of rusts, a short chapter on teretological features of rusts, and a chapter on classification."

Information Service in Plant Pathology. Last year the Advisory Board recommended that a plan be worked out for supplying the layman with information and news about plant pathology. The Council approved this suggestion and appointed W. A. McCubbin to consider the possibilities of developing such a service and, if it seemed feasible, to prepare a plan. Dr. McCubbin submitted such a plan to the members of the Advisory Board, who examined it critically and offered certain suggestions. Some of these are included in a revised plan presented to the Society at the Kansas City meetings and approved by it. The Council, upon the recommendation of the Advisory Board, has appointed W. A. McCubbin, F. C. Meier, and G. R. Lyman to a Committee on Information Service in Plant Pathology responsible to the Council, and has appointed W. A. McCubbin as publicity editor, with recommendation that the service be inaugurated.

Investigations on Plant Diseases and Fungicides Conducted by the Crop Protection Institute. The cereal seed treatment project was discontinued at the end of last year. The results of the work have been prepared for publication in PHYTOPATHOLOGY.

Furfural investigations were terminated on March 1, 1925. A paper, setting forth the studies on furfural, has been prepared for publication in PHYTOPATHOLOGY.

Scalecide investigations are supervised by a committee consisting of H. W. Thurston E. L. Nixon, P. J. Parrott, and H. W. Anderson. The main part of the investigation is being conducted by Mr. John Miller with headquarters at Pennsylvania State College. Studies are also being made in Massachusetts, and Illinois in cooperation with the Agricultural Experiment Stations of these respective states. The B. G. Pratt Company has provided $13,500 to continue the investigation for a period of three years. Prof. Thurston reports that the investigations thus far have indicated scalecide to have but little effect in stimulating or inhibiting the growth of apple tree. No definite effect on fire blight cankers on body and root has yet been observed. Studies are being made on the penetration of scalecide into the tissues of the apple tree in the hope of throwing some light upon oil injury. All three lines of investigation will be continued another year.

The crown gall investigations project is supervised by a committee consisting of I. E. Melhus, G. W. Keitt, and M. F. Barrus. The investigators are A. J. Riker and J. H. Muncie. Headquarters for the work are at Wisconsin Agricultural Experiment Station and Iowa Agricultural Experiment Station. Funds for the investigation amounting to $6000 a year have been furnished by the American Association of Nurserymen, by individual nurserymen, and by the Universities of Iowa and Wisconsin. The project has run for nearly two years and will terminate on June 30, 1926, unless additional aid is forthcoming. Some of the results of this investigation have already been published. Papers were presented at the Kansas City Meeting by Dr. Riker and Dr. Muncie. These and others will be published later.

The copper investigations project is supported by the Nichols Copper Company, the Baalbach Metals Corporation, the Goldsmith Brothers Smelting and Refining Company, and the Boyce-Thompson Institute for Plant Research, Inc. by Dr. Frank Wilcoxon under the supervision of a committee consisting of Drs. William Crocker, N. J. Giddings and R. W. Thatcher. The following statement of progress has been presented by Dr. Crocker.

"This investigation was commenced in May, 1925, and had for its immediate objective the preparation of a reversible colloidal copper fungicide which could be sold in concentrated form, and could be prepared for use by merely stirring into water. It was restricted to such compounds as would meet the requirements of a satisfactory fungicide as regards toxicity, cheapness, adhesiveness, harmlessness to foliage, etc. The work involved laboratory tests for toxicity, and adhesiveness, as well as the preparation and examination of a large number of copper-containing substances. Of these, two have been found which seem to warrant more extensive tests in the field, and it is hoped to carry out such tests next year."

The seed-borne parasites and seed disinfection project is supported by funds, amounting to $3,500 a year, appropriated by The Bayer Company and is conducted in cooperation with The Boyce-Thompson Institute for Plant Research at that Institute. The investigator, C. R. Orton, devotes half time to the project. The committee consists of William Crocker, who supervises the project, M. T. Munn, and W. L. Burlison.

An application for the incorporation of the Crop Protection Institute under the laws of the District of Columbia has been made and a revised Constitution and By-laws of the Institute to accord with the requirements of the law have been submitted to the members for a letter ballot.

REPORTS OF OTHER COMMITTEES AND REPRESENTATIVES

Auditing Committee. The Auditing Committee, S. M. Dietz, and J. L. Weimer, reported as follows:

The books of the Phytopathological Society were audited and checked with the resume presented before the Society on December 30, 1925.

The books of PHYTOPATHOLOGY as presented before the Society on December 30, 1925, were audited and found correct.

Representative on Committee on Plans for International Congress of Plant Sciences. H. H. Whetzel outlined the plans for the forthcoming Congress at the dinner on the evening of December 30. A summary of his remarks follows:

"The International Congress of Plant Sciences meets at Ithaca, N. Y., August 16–23, 1926. There will be some thirteen or more sections representing all branches of plant science, each with an executive secretary. Dr. D. Reddick is the Secretary of the Phytopathological Society and the program for this society is in his charge. The program will be made up of invitation papers, but ample opportunity for round table and general discussion will be provided.

"Field and collecting trips are being planned, at least one trip to nearby sections in the State where diseases of crops, especially of truck and field crops, may be studied. These will be arranged for by the officers in charge of the summer meeting of the Society.

"Cornell University will provide rooms and cafeteria service at a very reasonable charge and can handle all comers. A special effort should be made to make this the greatest international gathering of plant pathologists to date. Every American plant pathologist should plan to be there."

Representative on American Type Culture Collection Committee. Miss Margaret B. Church, in the absence of the Society's representative, C. L. Shear, presented a report embodying the following information:

"Maintenance of the fungi in the American Type Culture Collection is supervised by Drs. Charles Thom and Margaret B. Church of the U. S. Department of Agriculture, Bureau of Chemistry, Washington, D. C. The Microbiological Laboratory in this bureau has been maintaining successfully saprophytic molds in culture for numbers of years. The executive committee of the collection assigned to the project about $400 per year to be used by an assistant. This provides about ten hours per week service. When the temporary mimeographed list of the collection was issued in September 1925 the number of fungi included was about seventy. Other cultures of fungi have been and will be added as time and facilities permit. Cultures included are as free from contamination as can be ascertained and are identified by competent persons. Cultures are transferred in Washington and mailed to Chicago for distribution. New transfers are periodically sent to Chicago to replace the older ones. Current record books, a letter file and a card index are developed for the collection. The card index indicates the name of the fungus, the source of the particular culture, the date of its isolation, and the original citation. This collection of living cultures of fungi is of active interest to students, investigators, and those dealing with industrial and agricultural problems."

Resolutions Committee. The chairman of this committee, F. D. Fromme, presented the following resolutions, which were unanimously adopted:

1. *Resolved:* That the American Phytopathological Society expresses its appreciation of the progress being made by the Committee on American Type Culture Collections in providing supplies of pure cultures of bacteria and fungi, and urges that the collection of fungi, especially plant parasites, be increased as rapidly as possible.

2. WHEREAS: Plant pathologists have found the recent "Author and Subject Index to the Publications on Plant Pathology of the U. S. Department of Agriculture" very useful, and whereas a similar index of publications of State Experiment Stations would be equally helpful, therefore be it

Resolved: That the American Phytopathological Society assembled at Kansas City respectfully requests the Bureau of Plant Industry Library to consider the preparation of an author and subject index to the experiment station literature in the same manner as has just been done for the U. S. Department of Agriculture publications, and that copies of this resolution be sent to the Chief and to the Librarian of the Bureau of Plant Industry.

3. *Resolved:* That the editor and the editorial board of PHYTOPATHOLOGY are especially commended for the vigorous and heroic policy of improvement which they have inaugurated and followed during the past year; our support is assured for the application and further extension of this policy during the coming year. It is recognized that the excellence of the journal is due in no small measure to the activities and good judgment of the Business Manager and the Advertising Manager, and we further record our sincere appreciation of their work.

4. *Resolved:* That we record a most favorable reaction to the hotel type of convention and express a desire that arrangements for similar hotel meetings be made in the future when facilities permit.

5. *Resolved:* That we hereby express our appreciation of the excellent facilities for the business of our meetings and for entertainmnts that have been provided at Kansas City. This expression is especially tendered to the general officers of the American Association for the Advancement of Science; to the local committee for the Kansas City meeting; to the officers of the American Phytopathological Society and to its program committee; and to the management of the Hotel Baltimore.

6. *Resolved:* To the authors, producers and entertainers who are responsible for our dinner program, and to the founders of the Epsilon Phi Tau fraternity we express our thanks for a most enjoyable evening.

ACTION OF THE COUNCIL

In addition to the appointments mentioned in the first part of this report, the Council reported the following actions which were approved by the Society.

It was recommended that there be initiated the publication of a series of separate papers, independent of Phytopathology, consisting at the outset of translations of important classical articles. This series might be appropriately termed "Phytopathological Classics." These papers are to be sold at a profit sufficient to provide for the continuation of the series. The work of obtaining and preparing them is to be entrusted to an editorial committee of three consisting of H. H. Whetzel, Chairman, E. C. Stakman, and F. D. Fromme.

The Council recommended the appropriation of $300 from the treasury of the Society for the use of the International Congress of Plant Sciences, one-hundred dollars to be for the use of our representatives on the committee, and the sectional secretary, and the remaining $200 to be applied to the general fund.

Attention of members was called to the Pan-Pacific Science Congress which will be held at Tokyo, Japan. October 27 to November 9, 1926. Any members who think they will be able to attend are asked to communicate with the president or secretary in order that they may be properly appointed as delegates.

The Council adopted rules of procedure, proposed by the committee on Necrology, to be followed in connection with receiving the report of that committee and in obtaining and preparing biographies of deceased members. These rules are as follows:

1. The Committee recommends that the time of receiving the annual report of the Committee on Necrology be carefully chosen by the President or presiding officer with respect to full attendance and the avoidance of too great disharmony with what precedes and follows on the program.

2. The Committee recommends that the Society inaugurate the custom of standing while the annual report of the Committee on Necrology is received, or if this recommendation fails of approval, that the Council consider and inaugurate some other method of giving an appropriate degree of solemnity and distinction to this occasion.

3. The Committee recommends that a brief, but full page notice *in memoriam* be annually printed in the number of PHYTOPATHOLOGY in which the annual meeting is reported, following the custom inaugurated in the number of PHYTOPATHOLOGY, for May, 1925.

4. The Committee recommends that a suitable biography of every deceased member shall be published in PHYTOPATHOLOGY; that this shall, at the discretion of the editor-in-chief, be accompanied by a photograph and by a complete, carefully prepared bibliography, or a citation of a complete bibliography published in some other journal. It is further recommended that the Committee on Necrology shall be responsible for seeing that such a biography is suitably prepared and submitted for publication with reasonable promptness.

5. The Committee recommends that ten copies of the number of PHYTOPATHOLOGY in which any given biography appears, or ten reprints of the biography, shall be sent to the family of the deceased at the expense of the Society.

Committee on Necrology—Haven Metcalf, G. P. Clinton, and L. R. Jones.

MISCELLANEOUS BUSINESS

The reports of the various officers and committees as given in the preceding pages of this report were adopted. The Constitutional amendments as printed in PHYTOPATHOLOGY (Phytopath. **15**: 619–620, Oct. 1925) were adopted. The secretary's report of the last annual meeting as presented in PHYTOPATHOLOGY (Phytopath. **15**: 304–319, May, 1925) was accepted.

It was voted to hold the next annual meeting of the Society at Philadelphia in conjunction with the American Association.

In connection with the discussion for improving the quality of articles published in PHYTOPATHOLOGY, it was voted as the sentiment of the Society that the editor and management be authorized to announce that no papers would be accepted for publication in PHYTOPATHOLOGY that do not have the signature or approval of some member of the Society, or some botanist of recognized standing, this announcement and procedure to be at the option of the editor.

A motion to discontinue the printing of abstracts of papers that will be presented at the next annual meeting was lost, as was also the motion to print only abstracts of those papers that are actually presented at the meeting. In connection with a discussion of the program, it was voted, on motion by L. R. Jones, that it was the sentiment of the meeting that as far as possible the program committee be authorized to take steps to dignify, systematize and simplify the programs. It was also urged strongly that members should not present abstracts and titles unless they fully intend to be present at the meeting to present their papers.

It was suggested that, since simultaneous sessions appear to be necessary and desirable, chairmen of these sessions be appointed at an early date in order that they may take part in arranging the programs.

Notice was given of the annual meeting of the Southern Division, which will be held this year at the Biltmore Hotel, Atlanta, February 3, 4 and 5.

R. J. HASKELL, *Secretary.*

IN MEMORIAM

ELLSWORTH BETHEL, 1863–1925

"Professor" Bethel, as he was universally called, graduated from Grant Memorial University, Athens, Tennessee, in 1886. The University of Denver conferred on him the honorary degree of Master of Arts in 1905. From 1888 to 1917 he taught in the public high schools of Denver, Colorado. From 1917 until his sudden death he was a pathologist in the Office of Forest Pathology with headquarters at Denver. Self-taught in natural history, he began field work as an amateur, and achieved world-wide reputation as a collector. While his specialty was the Uredineae, he covered the field of botany and invertebrate zoology. His name is perpetuated in the Hymenopterous genus *Betheliella*, and the specific name *betheli*, applied to at least twenty species—rusts, flowering plants, fossil fungi, insects, mollusks, and even a variety of *Peripatus*. We remember him for his generosity to correspondents and to visiting scientists, to whom he delighted to unfold the scientific resources of Colorado.

FRANK JOSEPH PIEMEISEL, 1891–1925

Frank Joseph Piemeisel received the degree of Bachelor of Science in Agriculture from the University of Minnesota in 1914, and the degree of Master of Science in 1915. He was then employed by the Office of Cereal Investigations, and had made arrangements to pursue graduate work for the doctorate, when, on September 20, 1917, he was drafted into the army. During his service overseas with the Meteorological Section of the Signal Corps he contracted tuberculosis, and after 13 months returned to the United States, utterly incapacitated. In 1925, at the age of 34, he died of tuberculosis at the Veterans' Bureau Hospital in St. Cloud, Minnesota.

A serious minded student in whom the desire and joy of study was inborn, Frank Piemeisel demonstrated his outstanding ability in research while in the Office of Cereal Investigations, an ability which predicted leadership in the field which he had chosen for his life work.

IN MEMORIAM

JOSEPH ROSENBAUM, 1887–1925

Born in Russia, descendant of a long line of Jewish Rabbis, Rosenbaum came to America at the age of nine. He was graduated in 1911 and received the degree of Doctor of Philosophy in 1914 from Cornell University. In 1915 he was instructor in Plant Physiology in Cornell: from 1915 to 1920 with the Bureau of Plant Industry, engaged mainly in the study of potato and tomato diseases. From 1920 until his untimely death he was in charge of the department of Biology at the Milford Preparatory School, Milford, Connecticut. For one whose years in productive research were so few, he made a notable number of contributions to science.

MARK ALFRED CARLETON, 1866–1925

Mark Alfred Carleton received the degree of Bachelor of Science from the Kansas Agricultural College in 1887, and the degree of Master of Science in 1893. He held successively the chairs of Natural History at Garfield University and at Wichita University and was for a time Assistant Botanist at the Kansas Experiment Station. In 1894 he became a pathologist in the U. S. Department of Agriculture. From 1901 to 1918 he was Cerealist in Charge of the Office of Cereal Investigations, except for a brief period in 1913–14 when he was furloughed to take charge of the chestnut blight control campaign of the State of Pennsylvania. Taking up commercial work in 1918, he was successively with the U. S. Grain Corporation, the United Fruit Company, and at the time of his death with the Laboratorio de Plagas Algodoneras at Piura, Peru.

Carleton was best known as an agronomist, in which line of work, by the introduction and establishment of durum wheat, Swedish Select oat, Khakof wheat and other grains, he made monumental contributions to the prosperity of the United States. But his early work and his last was in plant pathology; and his achievements in agronomy were the outgrowth of his studies on the Uredineae. "He established the physiological relationships of nearly all the cereal rusts of this country and demonstrated the distinctness of the different forms of the same species of these rusts adapted to the same hosts, traced the yearly cycle of the orange leaf-rust of wheat, and showed that durum wheat, emmers, einkorns, and some other wheats are more or less resistant to rust." His position in science and in agriculture is secure, resting solely upon his own achievements.